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Using Low Grade Hardwood
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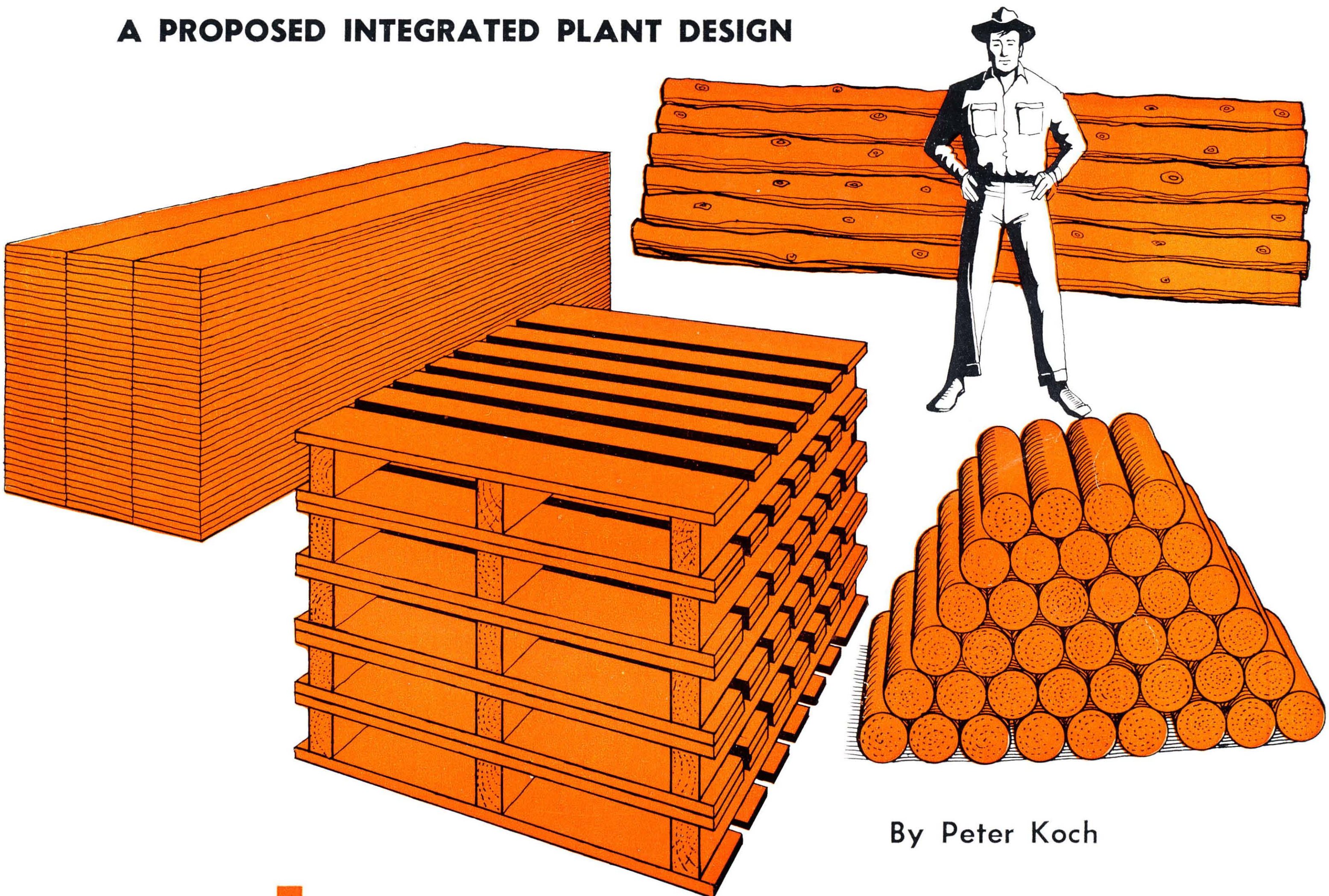
USING LOW-GRADE HARDWOOD

A PROPOSED INTEGRATED PLANT DESIGN



By Peter Koch

Agricultural Experiment Station
MICHIGAN STATE UNIVERSITY
Department of Forest Products • East Lansing

PREFACE

MORE than one-half of the total land surface of the State of Michigan is forested. In some counties the forest occupies in excess of 80 per cent of the area. While the overall volume of standing timber in Michigan is increasing year by year, the major part of this growth is taking place in stands of low grade hardwood timber. For this reason the economic utilization of the forest resources in Michigan presents a complex and difficult problem.

The technical difficulties involved in converting low grade hardwoods to a variety of usable products have been largely solved. By contrast, the solution to the economic problems of such utilization has been lagging behind. This publication presents an economic analysis of a proposed integrated plant design that may provide a partial solution to the problem.

A. J. Panshin, Head
Department of Forest Products

CONTENTS

Using Low-Grade Hardwood

A Proposed Integrated Plant Design

By Peter Koch, Department of Forest Products

INTRODUCTION

THIS IS A PROPOSAL for further developing wood utilization in the state of Michigan. Although the proposal is centered on a Michigan location, it should apply equally to other northern and eastern hardwood regions.

Michigan once had a vigorous and prosperous lumber industry. Today, however, urban Michigan residents are likely to think that the state's lumber industry is made up of a number of small, marginal endeavors. They see individual operators who use simple, circular headrings and manufacture slightly more sawdust and slabs than lumber.

This view of the industry is held not only by potential entrepreneurs but also by bankers and others capable of financing wood utilization ventures. Therefore, it is not surprising that the mechanical aspects of wood utilization technology, so well developed in other parts of the United States, have not been applied in Michigan.

Furthermore, entrepreneurs and investors tend to consider the present mixed hardwood forests covering much of Michigan as so much brush, having neither the volume nor the quality to support a profitable business. They may be right if 1920 methods are used to convert the timber into salable lumber products. However, if manufacturing methods that have been well developed in other timber-producing areas of the United States are applied, the picture could be changed considerably; the forest cover could be a much more valuable resource.

Compare the assets of this area in competing with forest products from other areas. First and perhaps foremost, this forest area is near the rich and active industrial heart of the United States with its large population centers. Transportation costs to industrial and consumer outlets are low. Secondly, due to the present low demand, the area's timber is moderately priced. Finally, skilled and unskilled labor is available at reasonable cost.

Why, then, has economic use of this forest resource been so uncertain and unprofitable? The answer lies in the outdated manufacturing methods, perhaps forced on the operator from lack of capital, which have prevented him from taking advantage of the natural competitive assets of the region. Since operators in these forest regions have access to the mechanical "know-how" of nearby industry, it is all the more astonishing that the lumber industry in this area has remained so aloof from change in mechanical methods.

Keeping in mind the poor quality of the timber, what products can be profitably manufactured from the forest resource? There are many answers, no doubt, but the solution presented here capitalizes on three aspects of the market.

First, the Midwest is a major market for industrial fork lifts; it logically follows that it also uses large numbers of pallets. Since pallets do not require high-grade lumber, they can be made from the available trees.

Second, the market area contains one of the major concentrations of furniture manufacturing plants in the United States. Thus, there is a strong demand for any high-grade lumber that may be developed in the process of sawing lumber for pallets.

Third, the market area contains a large concentration of consumer buying power. Here, the interesting statistic is the number of homes with fireplaces. These millions of residential fireplaces represent a market for fireplace fuel. It can be partly satisfied with log-size briquets formed from the waste products of the lumber manufacturing operation, i.e., suitably processed sawdust, slabs, and edgings.

A plan designed to capitalize on the forest resource, and the reasoning behind its development in this particular form, are presented in considerable detail on the following pages. In brief, it requires a plant investment of about 1 million dollars to achieve gross annual sales of about 1.3 million dollars, yielding a calculated net profit before federal income taxes of about $246,000 or 22.7 percent of investment.

This plant is designed for a total employment of 95 people with an annual payroll of $372,000. It would produce nearly 10 million board-feet of lumber per year, of which 12 percent would be sold as air-dried No. 1 common and better lumber, and the balance would be manufactured into wooden pallets. In addition, 14,530 tons of fireplace-size log briquets would be produced per year.

The market area involved has an average radius of 330 miles from the plant site, and includes southern Michigan, northeastern Illinois, northern Indiana, northern Ohio, and western New York. The detailed development of this plan follows.

Objective

This study is concerned with the utilization of low-grade hardwood stands in the northern portion of Michigan's lower peninsula. The proposed integrated plant is, however, equally applicable to other northern areas in the United States having similar timber stands that are relatively close to industrial and home markets.

As its primary objective, this proposal aims at the *profitable* and complete utilization of low-grade forests containing small-diameter, low-density stands of mixed hardwood species. The word profitable is underscored to stress the necessity of a paying operation that will be attractive to venture capital and which, at the same time, will permit payment of something more than subsistence wages to the men who operate the plant.

It is also desirable, (perhaps necessary in the area under consideration) that any plan evolved must aid in regenerating a more desirable forest type in the area of operations. If this is not possible, the operation should leave the forest no more difficult to deal with silviculturally than before. Furthermore, such a project should not be detrimental to natural resources such as water, fish, and wildlife.

Method

As already stated, these forests contain mostly very low-grade logs. These low-grade logs yield only a small percentage of No. 1 common and better lumber; therefore, the uses to which the resulting lumber can be put are quite limited.

In selecting a manufacturing process for more complete utilization, it was decided not to pursue a plan which would utilize the wood resource simply as fiber for reconstituted products, but rather to make the lumber the primary product with a secondary product to be made from the refuse.[1]

Plans also call for the No. 1 common and better lumber that developed to be sold f.o.b. mill (rough, air-dried, and sorted for species, length, thickness, and width). It was further decided that the lower grade lumber which predominates in such an operation would be remanufactured into wooden pallets, pallet boxes, skids, grain doors, and other similar uses for which high-grade lumber is neither essential nor economic.

In the resulting layout, the waste (consisting of barky slabs, barky edgings, sawdust and shavings) would be made into log-size wood briquets for fireplace use. A major factor contributing to this decision is the fact that the species are mixed. It was felt that, at the present stage of development, the pulp companies within economic hauling distance would not be a profitable enough market for some species as oak. Furthermore, utilization of residues such as pulp chips involves whole log barking before sawing and classification of chips by species. Moreover, the residue consisting of sawdust and shavings is not normally suitable for pulp purposes (under some circumstances, a certain percentage of shavings have been used in pulp operations; in this case, the shavings are briquetted prior to digestion).

Market Potential

No. 1 Common and Better Lumber

In deciding on these three final products (air-dried No. 1 common and better lumber sold f.o.b. mill; pallets and similar products sold to the in-

[1]This decision is quite possibly open to question on the grounds that utilization of a low-grade wood resource is more profitably accomplished through its utilization as fiber. However, it is not the purpose of this paper to compare the two possibilities, i.e., use as lumber versus use as fiber, but rather to assume the use as lumber and begin from this point.

*TABLE 5—Annual consumption of lumber in wooden pallets**

Year	No. of units	Dollar value	Millions of board-feet
1945.....	30,000,000	not available...	.....
1950.....	23,000,000	not available...	.....
1951.....	27,000,000	$60,750,000	.....
1952.....	33,000,000	74,250,000	.....
1953.....	40,000,000	100,000,000	.....
1954.....	36,000,000	86,000,000	.....
1955.....	43,000,000	107,500,000	1,075

*Source: The National Wooden Pallet Manufacturer's Association, Washington D. C.

the annual pallet consumption in the market area.

If we assume that pallet use distribution is proportional to population, the market region under consideration should absorb 7.8 percent of the national consumption of lumber for wooden pallets (see Table 6). Based on the Association figures, this amounts to 84 million board-feet annual consumption.

*TABLE 6—Tabulation of population in urbanized regions of the market area**

Urbanized area	Population
Chicago....................	5,253,647
South Bend.................	168,165
Fort Wayne.................	140,304
Grand Rapids...............	226,817
Kalamazoo..................	83,332
Lansing....................	134,052
Flint......................	197,631
Detroit....................	2,659,398
Toledo.....................	364,344
Cleveland..................	1,383,599
Akron......................	366,765
Buffalo....................	798,043
	11,776,097

*Source: 1950 U. S. Census.

In reviewing the above information, note that the estimates for annual pallet consumption in the market area range from a low of 62 million board-feet to a high of 204 million board-feet. If the lower figure of 62 million board-feet is selected as the correct estimate, it is a conservative choice for two reasons.

The market area, because of its industrial concentration, can reasonably be expected to use more pallets per unit of population than other less industrialized areas. In addition, the projected national consumption of wooden pallets is expected to rise substantially in the future (see Table 5).

Since the manufacturing layout selected calls for an annual pallet production of 8.466 million board-feet, about 13.6 percent of the available market must be captured.

The National Wooden Pallet Manufacturer's Association estimates[4] the average price of pallets, based on the board-foot content, at $100 per 1,000 board-feet. Personal investigation in the Detroit-Flint area indicates a delivered price of over $110 per 1,000 board-feet. It is felt that, due to manufacturing economies (to be described in detail in a later section of this report), a delivered sales price of $100 per 1,000 board-feet of lumber contained in the pallets is competitive enough to capture the necessary percentage of the market and still permit a respectable margin of profit.

Fireplace Briquets

In considering fireplace-size fuel briquets, we can be guided by the market experience of other producers. While log briquet machines are in operation in numerous places in the United States and elsewhere (sites for United States operations include such cities as Newark, New Jersey; Johnson City, Tennessee; and Memphis, Tennessee), their main concentration is in the northwestern section of the United States.

For example, there are a number of machines in operation at the Everett Division of the Weyerhaeuser Timber Company in Everett, Washington. They are used to consume part of the refuse from a pair of mills that cut 180,000,000 board-feet per year. This operation serves an urban area having a population of about 800,000 people. A second Weyerhaeuser operation uses part of the refuse from a number of mills in Longview, Washington, with a capacity of 300,000,000 board-feet per year. This operation serves an urban area with a population of perhaps 550,000 people.

A third operation in Vancouver, Canada, markets perhaps 10,000 tons of briquets per year in an urban area with a population of about 750,000 people.

It is calculated that the operation under consideration will turn out 14,530 tons per year of fire-

[4]See footnote 3.

place-size log briquets. If the area for this product is limited to Flint, Lansing, Grand Rapids, Muskegon, Midland, Bay City, Saginaw, and Detroit, it is still an immense market with a population of about 3,476,000 people. The center of this population group is about 220 highway miles from the area of operations (Fig. 1).

Since the proposed market area for briquets includes at least four times as many people as the market area being serviced by similar installations in the northwest, it seems reasonable to assume adequate demand for the product. This assumption is strengthened considerably by the fact that winters are longer and more severe in the midwest than they are in the Puget Sound area of the northwest. Table 7 indicates the probable future demand trend for fireplace fuel wood. As the figures indicate, a demand growth of perhaps 50 percent is anticipated by the year 2000.

*TABLE 7—United States estimated consumption of fuel wood in fireplaces**

Year	Millions of cords (76 cubic feet of solid wood/cord)
1940	12
1950	14
1960	14
1965	15
1970	16
1975	17
2000	21

*Source: Stanford Research Institute.

A delivered price to the wholesaler of $21.60/ton in bulk sales (i.e., not packaged) seems reasonable since good fireplace cordwood is being retailed in the Detroit area for about $27/ton (12 percent M.C.). In the wood-rich area and mild climate of Vancouver, British Columbia, Canada, *packaged* briquets of the general type under consideration wholesale at $22.90/ton and retail on a delivered basis at $27.80/ton.

Major Assumptions

In general, the proposed manufacturing plan is designed as a complete operation; it begins with the purchase of standing trees in the forest and continues through the logging phase to the sawmilling process; it is followed by air drying in the case of No. 1 common and better lumber, fabrication of pallets from the lower lumber grades, manufacture of log-size briquets from the refuse, and, finally, transporting both pallets and briquets to market.

In the design of the operation, some major assumptions are outlined as follows:

1. Geographical location of operation: A circle of about 38-mile radius located in the Petoskey, Onaway, Atlanta, Grayling, Kalkaska and Gaylord area of Michigan's lower peninsula (Fig. 1).
2. Species cut: About one-third oak, one-third aspen, and one-third mixed northern hardwoods (principally elm, maple and beech). Obviously, there will be considerable volumes of other species in addition to these, but variance of species is of small importance to the operation.
3. Average tree size: 25 feet in length before reaching a minimum top diameter of 6 inches inside bark, with a midpoint diameter inside bark of 9 inches.
4. Average bucked log size: 10 feet long and 9 inches in diameter. Maximum log length 12 feet. Minimum log length 8 feet. Minimum top diameter inside bark 6 inches.
5. Average log grade: Number 3 (U.S. Forest Service hardwood log grade).
6. Average stumpage rate: $6.50 per 1,000 board-feet net board scale.
7. Minimum cut per acre: 1,000 board-feet per acre based on net lumber scale, or about 15½ average trees per acre.
8. Radius of working circle: 38-mile extreme radius with an average haul of 25 miles.
9. It is estimated that 25 percent of the area within the working circle area of 2,910,000 acres carries stands of hardwood timber which, per acre, contain more than 1,000 board-feet of logs in the size classification under consideration. It is further estimated that an average acre in this 25 percent of total land area contains trees that will yield 2M board-feet of lumber when processed in the proposed plant. Thus, in the working circle, the total resource available (in the size classification under consideration) is 1,500,000M board-feet.

10. If we assume that the allowable annual cut is 3 percent of this total volume, it amounts to 45,000M board-feet. Thus, the proposed plant would be absorbing perhaps 22 percent of the allowable cut in the particular size classification under consideration (the estimated annual plant consumption being about 9,620M board-feet). It is estimated that the difference between the allowable cut and the present annual drain of this type of stock will readily support the contemplated additional demand.
11. Rate of consumption of logs through sawmill: One average log every 15 seconds, sustained at 80 percent efficiency (each such average log yielding a net board scale after all deductions of 25.8 board-feet).
12. Average wage: $1.74 per hour.
13. Percent of theoretical footage lost to rot, excessive defect, crooks and sweep in logs, etc.: 20 percent.
14. Percent of sawn lumber lost in the process of trimming to suit pallet dimensions: 10 percent.
15. Percent yield of No. 1 common and better lumber in the net board tally: 12 percent.
16. Net board scale yield: 39,600 board-feet per shift or 9,620,000 board-feet per 243-day working year on a one-shift basis. Of this, 8,466,000 board-feet would be manufactured into pallets and the balance would be sold as air-dried No. 1 common and better lumber.
17. Percent of gross log volume (solid basis with bark included) destined for briquetting plant: 60 percent. It is assumed that one-fifth of this volume is consumed in drying the remaining four-fifths to the proper moisture content for the log-size briquets. This assumption results in an estimated net production of 14,530 tons of briquets per year (8 percent moisture content).
18. Assumed average distance of highway haul to market: 660 miles round trip for pallets, 440 miles round trip for briquets (air-dried No. 1 common and better lumber sold f.o.b. mill).
19. Assumed average selling price of products: $100 per 1,000 board-feet on net scale in pallets, delivered basis; $21.60 per ton of bulk, unpackaged briquets delivered to the wholesaler; $120 per 1,000 board-feet of rough air-dried No. 1 common and better lumber sorted for length, width, thickness and species (f.o.b. mill).

Description of the Manufacturing Process

The logging operation proposes tree length logging by means of track-laying tractors with ground skidding pans and towing winches. The desired production of 40,000 board-feet per day would require the logging of a maximum of 40 acres per day (an average of 20 acres per day).

This maximum can be accomplished by locating truck haul roads about 1,320 feet apart, depending on terrain. Since 40 acres is enclosed in a 1,320-foot by 1,320-foot square, each 40-acre compartment could be logged from two landings 660 feet apart on the haul road that runs through the center of the compartment.

Thus, the maximum skidding distance on level terrain to either landing would be 738 feet, with an assumed average skidding distance of 450 feet.

Using a track-laying tractor with drawbar pull in second gear of 6,930 pounds, the per trip log load capacity on level terrain is 8,160 pounds of logs. This would be 13 tree-length logs at an estimated log density of 54 pounds per cubic foot. This towing capacity is based on a sliding resistance of 1,700 pounds per ton of log weight (Fig. 2).

The estimated time cycle is as follows:

Winching and choking at a minute per log (13 logs)	13.0 minutes
Travel loaded in second gear at 238 f.p.m. (450 feet)	2.0 minutes
Unhook at landing at 0.5 minutes per log (13 logs)	6.5 minutes
Decking	2.0 minutes
Travel return in fourth gear at 370 f.p.m. (450 feet)	1.5 minutes
Miscellaneous time	1.0 minutes
	26.0 minutes

Fig. 2. Diesel tractor (48 drawbar horsepower) equipped with towing winch pulls logs from woods to landing. This operation would use three of these machines, each equipped with a skidding pan (not shown) to decrease skidding resistance and thus increase the number of logs hauled per trip. It is estimated that these three units will bring 40,000 board-feet of logs to the access road landings each 8-hour shift. (Photo: Caterpillar Tractor Co.)

On the basis of a 52-minute hour (86.6 percent efficiency), two trips could be accomplished per hour with a volume of 1,676 board-feet per hour per tractor. If each tractor handles 13,400 board-feet per 8-hour day, three tractors of this capacity will be required. Working with the three tractors would be three choker setters and one unhooker, located at the landing. It is estimated that five felling teams of two men each (assisted by a full-time forester) bossed by a woods foreman can keep up with the production requirements.

The roadbuilding team would consist of the driver for a track-laying tractor (of about 75 drawbar horsepower and equipped with a hydraulic angling blade and towing winch), a driver for a motor grader, and a roadbuilder's helper (Figs. 3 and 4).

The logging trucks would consist of three 220-horsepower tractors with semi-trailers having a hauling capacity of about 20 tons each. These trucks can be loaded at the landings by a rubber-mounted crane equipped with a grapple (Fig. 5). If each truck makes four 50-mile round trips to the mill daily with an average load of 18 tons (i.e., 52 tree-length logs weighing 700 pounds each), they would deliver the required 40,000 feet board measure per day (Figs. 6, 7 and 8).

At the mill, the logs are unloaded onto the bucking deck by a 20-ton crane that removes the entire load in one sling.

Fig. 3. Diesel tractor (75 drawbar horsepower) equipped with bulldozer and towing winch builds a winter haul road on a logging job. One such machine would be needed to build access roads for the three 20-ton capacity logging trucks. (Photo: Caterpillar Tractor Co.)

At the bucking deck, the tree-length logs are scaled and then sent to the bucking sawyer who bucks them into logs ranging from 8 to 12 feet in length, depending on the log and the pallet order for which he is cutting (Fig. 9).

The odd ends, trimmed defects, etc., are conveyed to a hog, the effluent of which goes to the briquetting plant. The bucked logs go to a log sorter (Fig. 10) where a sorterman can divert them for momentary storage according to length, diameter class, and species. From here, the logs

(Continued column 2, page 12)

Fig. 4. Diesel motor grader (50 brake horsepower) working on logging road. This machine, plus one 75-horsepower diesel tractor, builds and maintains the access haul roads to the logging operation. (Photo: Caterpillar Tractor Co.)

Fig. 5. Mobile log loader equipped with a 52-foot pipe boom and log grapple. The machine shown is considerably larger than the unit needed for this operation, but it illustrates the principle. In the proposed operation, 40,000 feet of logs must be loaded from the access road cold deck to sawmill-bound log trucks each 8-hour shift. The single operator not only controls the crane action but can also maneuver the truck. Use of a grapple eliminates the need for a log tong setter. (Photo: Baldwin-Lima-Hamilton Corp.)

Fig. 6. This photograph (from an enterprise in eastern Washington) shows a 40-ton maximum capacity truck with a load of lodgepole pine logs in the same diameter class as the hardwoods involved in the operation under consideration. Because of local load limitations, more trucks (having a load limit of only 20 tons each) must be used in this operation. (Photo: Biles-Coleman Lumber Co., Inc.)

(Continued from page 11)

are stored in sorted cold decks until enough logs of a certain kind have been accumulated to permit at least one-half day's run (770 logs).

Fig. 7. A 220-horsepower cab-over tractor with 9,000-pound front axle and 22,000-pound rear axle. The cab-over design will permit maximum load lengths and still meet local regulations governing maximum loads. Three such tractors with matching trailers are needed to transport 40,000 board-feet of tree-length logs from woods to mill in an 8-hour shift. (Photo Reo Motors, Inc.)

Fig. 8. Twenty-ton capacity trailer with 109-inch tandem to permit maximum loading and still meet local load limitations. Because of the necessity of hauling numerous short logs that develop along with the tree-length logs, a modified platform trailer may serve better than a conventional log trailer. Three such trailers, modified for carrying logs of mixed length, are required for the operation. (Photo: Trailmobile, Inc.)

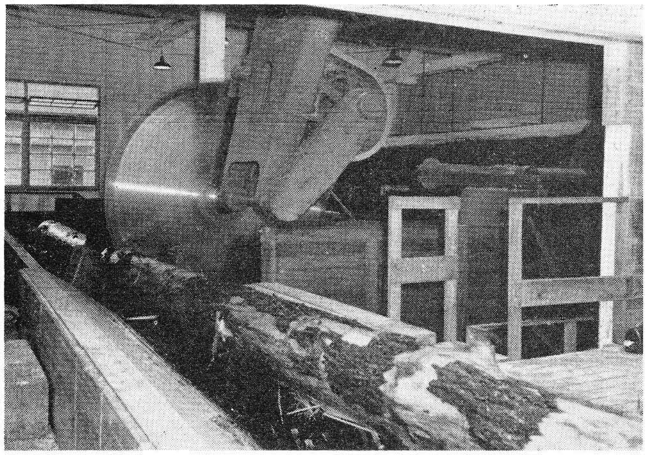


Fig. 9. Circular, 48-inch diameter swing cutoff saw with air feed cylinder. Log dogging jaws which will accomodate themselves to burly or uneven logs are visible to the left of the saw line. Here logs are bucked into exact lengths ranging from 8 to 12 feet to produce a multiple of the desired pallet board length. This equipment is located at D in Fig. 10. (Photo Sumner Iron Works)

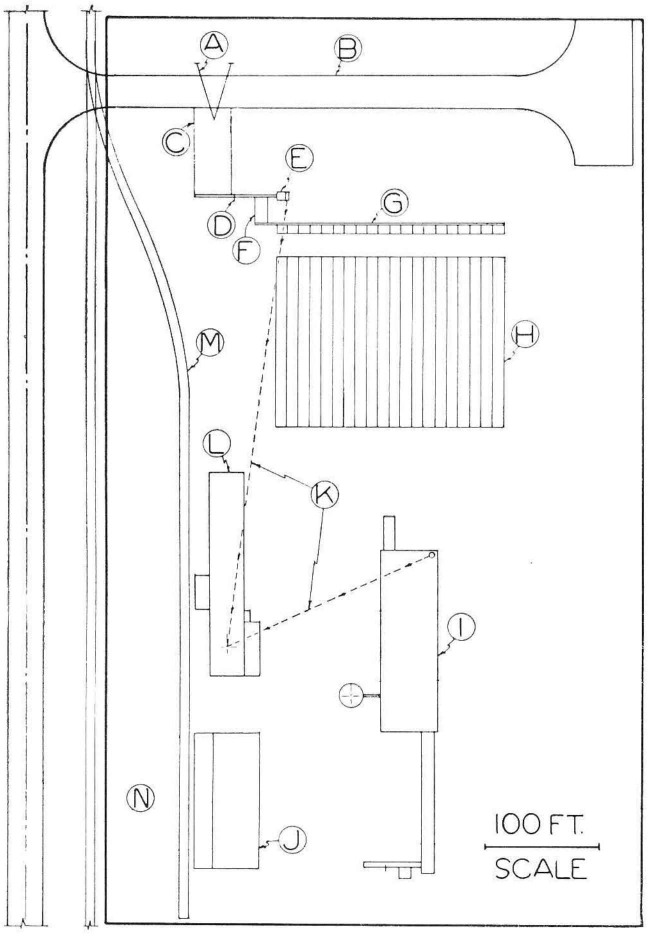


Fig. 10. Layout of manufacturing plant and yard. This layout is designed to use 40,000 board-feet of logs each 8-hour shift. Pallets, No. 1 common lumber, and fireplace-size fuel briquets are the end products. The plant has no waste products.

a. Unloading crane (truckload capacity).

b. Log truck unloading apron and turn-around.

c. Live bucking deck for tree-length logs.

d. Log cutoff saw (Fig. 9).

e. Hog to receive reject wood.

f. Live deck for bucked logs 8 to 12 feet long (feeding log sorter).

g. Log sorter—20 sorts to temporary log storage.

h. Storage deck for sorted logs.

i. Sawmill (Fig. 12).

j. Nailing plant.

k. Blow pipes delivering green hogged refuse to briquet plant.

l. Briquet plant (see Figs. 27 and 28 for alternate plans).

m. Railroad siding.

n. Loading apron for trucks hauling pallets and briquets to market.

From the cold deck, the logs are carried to the log deck of the sawmill (Figs. 10 and 11) by a heavy-duty forklift. As shown in the mill layout (Fig. 12), the logs are directed up the jack ladder to the top log deck where the sawyer of the two-saw "skrag" mill (Figs. 13, 14 and 15) drops them onto the feed chain which carries them through the saws.

(Continued column 2, page 15)

Fig. 11. All movement of logs in the mill area (from log sorter to log storage and from log storage to sawmill deck) is handled by this versatile four-wheel drive fork lift. It is estimated that one operater with such a machine can keep the mill supplied with 40,000 board-feet of logs per shift. (Photo: Pettibone Mulliken Corp.)

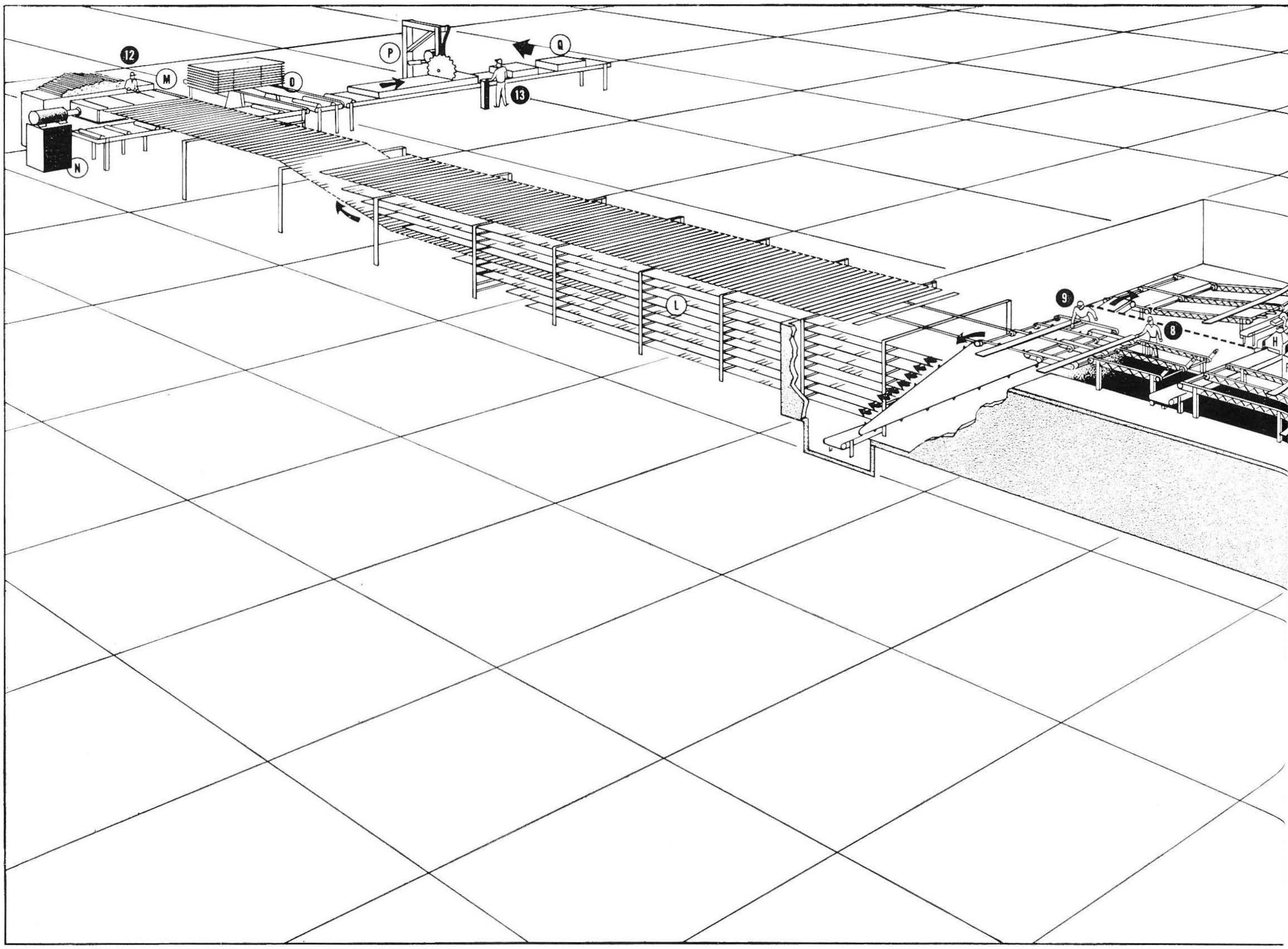
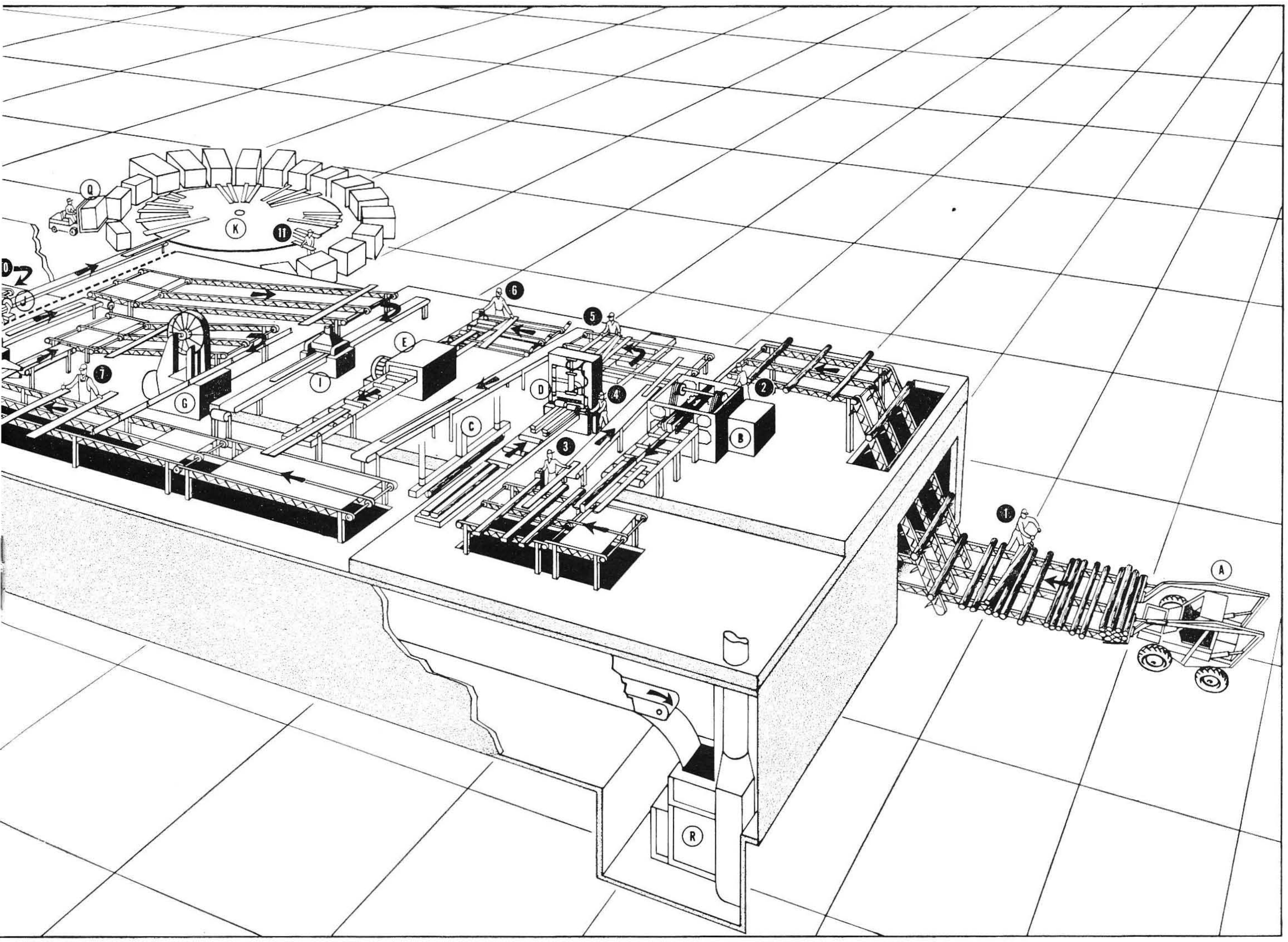


Fig. 12. Layout of sawmill*. The sawmill is designed to utilize logs at an average rate of one every 18 seconds, or 40,000 board-feet per 8-hour shift. The logs average 9 inches in diameter and 10 feet in length. Pages 13 through 19 of the text describe the flow of material through this portion of the manufacturing process.

Men	Machines	Reference Fig.
1. Log elevator loader.	A. Forklift for logs (coming from log sorter).	Fig. 11
2. Sawyer.	B. Two-saw pole (or "skrag") sawmill.	Figs. 13, 14, and 15
3. Crane operator stacking cants on gangsaw infeed table, and diverting side cuts around the gangsaw.	C. Crane for stacking cants.	Fig. 16
4. Gangsaw operator.	D. Split roll gangsaw.	Fig. 17
5. Gangsaw tailoff man, separating (by means of solenoid and air-operated dropout chain section) stock that requires edging from stock that does not require edging.	E. Power-shift edger.	Figs. 18 and 19
6. Edger operator.	F. "Electric Swede".	Fig. 20
7. Grader — decides which stock should be resawn, surfaced, or passed out of mill.	G. Self-feeding and tailing self-centering resaw.	
8. Loader man of lugged chain feeding sorter.	H. Continuous belt single surfacer.	Fig. 21
9. Sorter operator.	I. Board turner and single surfacer.	
10. Operator of twin saws salvaging boards with excessive defects.	J. Twin trimsaws.	Fig. 25
11. Sorter man.	K. Turntable for sorting shorts.	
12. Package stacker (stacking with or without sticks, as the case may be).	L. Lumber sorter.	Figs. 22 and 23
13. Sawyer operating package cutoff saw.	M. Semiautomatic stacker.	Fig. 24
	N. Ram to square completed packages.	
	O. Jack chains via which No. 1 common and better lumber starts enroute to air-drying yard.	
	P. Package cutoff saw (somewhat similar to Fig. 9 but incorporating top and side clamps).	
	Q. Sorted and trimmed-to-length-stock, stacked and ready for pallet assembly plant.	
	R. Hog for slabs, edgings and trim ends.	

*Scale: The grid squares measure 20 feet on each side.



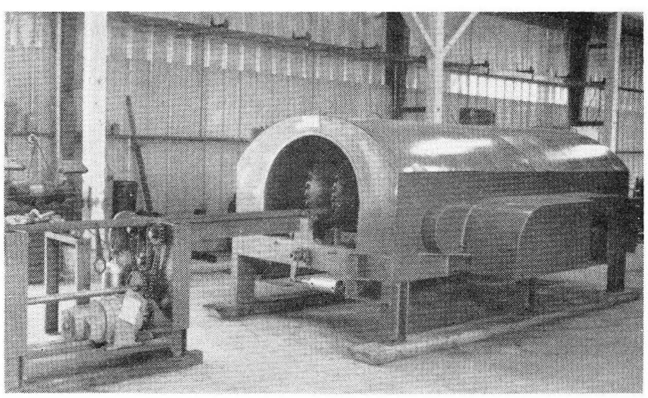


Fig. 13. Infeed end of a multiple-saw pole (or "Skrag") mill. The saws can be spaced by remote control to cant each log with a minimum thickness slab. The feed works is provided with a log turning device which positions the log for maximum yield. The feed chain is continuous through the machine, and logs travel straight through in an uninterrupted fashion. (However, if an occasional log requires it, the feed chain can be reversed and the cant brought back to the infeed end; then, the saws can be re-spaced and side cuts taken on a second pass.) ..The machine for this operation should carry only one pair of saws. (Photo: Keystone Machine Works)

(Continued from page 13)

The sawyer is equipped with a log turning device for positioning the log. If the grade of the log warrants, he can reverse the feed and bring the slabbed log back to the infeed position, adjust the saws to a new position, and take two side cuts.

As Fig. 12 shows, man number three can divert the small volume of side cuts around the cant gangsaw. With his right hand, man number three operates the overhead crane C (Fig. 16) with which he can pile the cants in multiples to be fed through gangsaw D (Fig. 17).

The sawn stock emerging from the gangsaw is unscrambled by the fifth man in the operation. He separates the lumber which requires edging from that which does not need it and bypasses that portion of the lumber that does not require edging to the grading chain. Man number six, using a power-shift, remote-control, high-speed edger, edges all stock that needs it (Figs. 18 and 19).

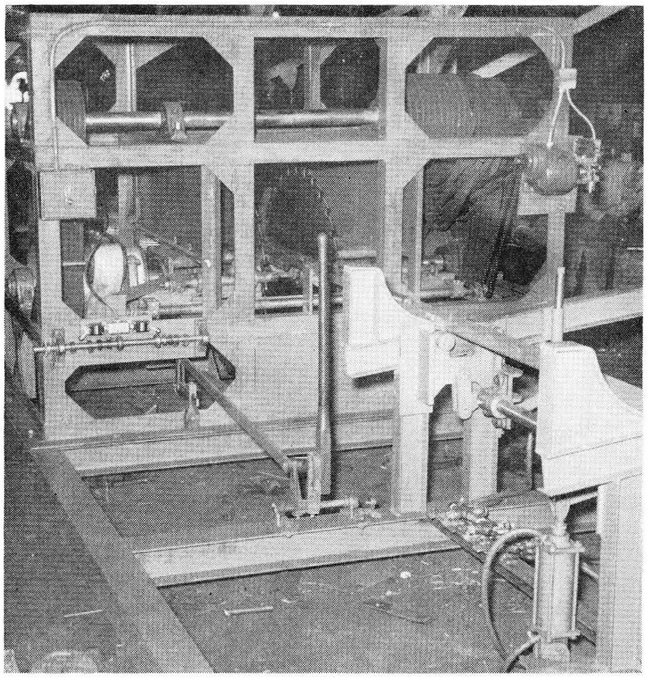
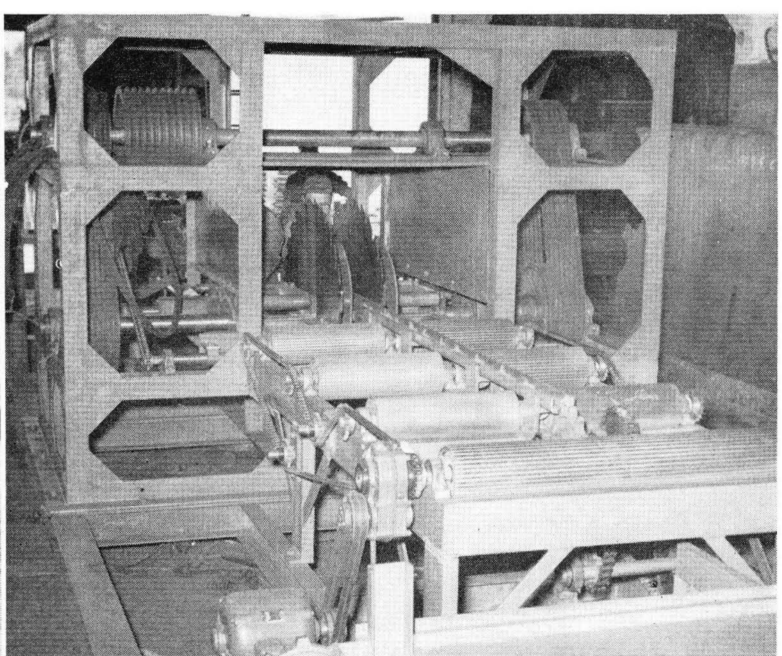


Fig. 14. Infeed end of a two-saw pole mill. The logs can flow continuously through the mill at a sustained rate of one 10-foot log every 18 seconds. The log deck and air-operated log stop are to the right. The sawyer's feed control lever is in the center foreground. Spacing of the two saws is instantly adjustable to conform to log size. (Photo: Salem Equipment and Supply Company)

Fig. 15. Outfeed table of two-saw pole mill. Note the splitters which operate in the kerf behind the saws. From this point, the cants are delivered to a gangsaw for manufacture into lumber, and the slabs are hogged for conversion into fuel briquets for fireplaces. (Photo: Salem Equipment and Supply Co.)



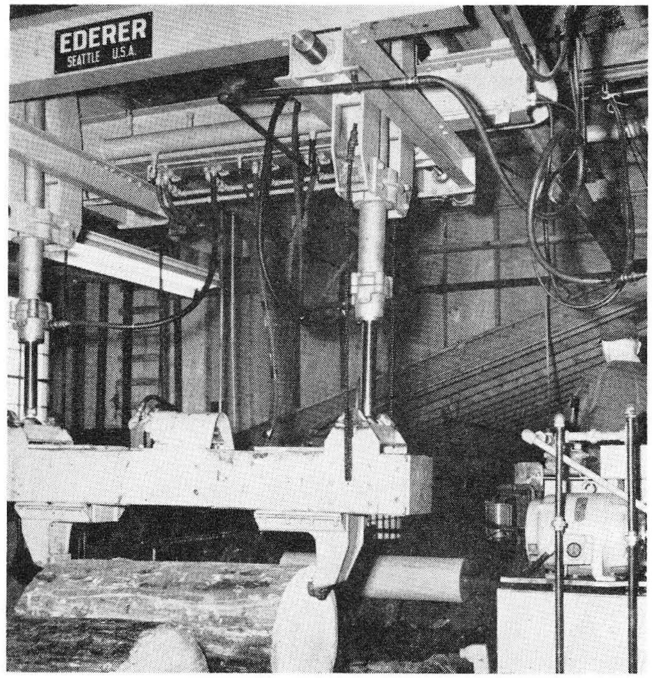


Fig. 16. Overhead charging crane to service the cant gangsaw. Here it is being used as a lathe charger and is considerably heavier than required for stacking cants on the gangsaw infeed table, but it illustrates the principle. The design of the crane permits precise alignment of the cant for maximum lumber yield. By stacking the cants in multiples of four, the gangsaw can easily keep up with the production of the pole mill. (Photo: Edeher Engineering Co.)

Eight-quarter stock that can be economically cut into 2 by 4's is sized accurately on a bank of saws, spaced 4 inches apart, that remain in a fixed position on the right hand side of the edger. A waste trough extends below the primary grading chain so that all slabs and edgings can be tipped into the trough which, in turn, delivers the refuse to the hog (the effluent of which is blown over to the briquetting plant).

The number seven man, the grader, plays a key role in this operation. He controls the stock that is to be resawn and double surfaced. If he wants a piece of lumber to be resawn (either eight-quarter resawn to four-quarter or four-quarter resawn to three-eighths), he merely pulls the board out 1 foot past the lumber line where it is caught by the "electric swede" F (Fig. 20). This jerks the lumber onto a transfer chain which delivers the board to self-centering resaw G; this, in turn, delivers the board back to the grading chain.

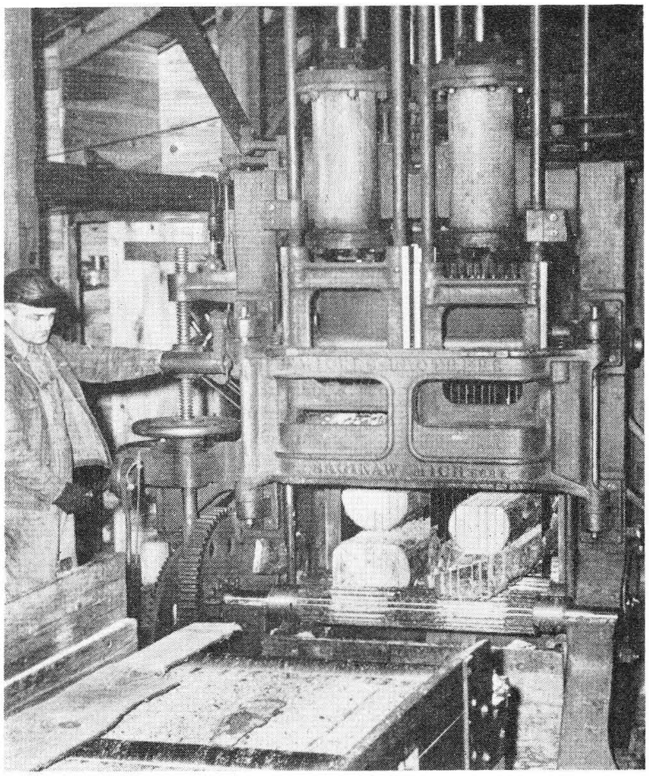


Fig. 17. Sash gangsaw measuring 32 inches between styles or sash, with a stroke of 13 inches, depth of cut of 14 inches, and with 15½-inch maximum opening between feed rolls and press rolls. Note individual pressure cylinders actuating the split press rolls to permit feeding of multiple cants. By feeding cants in multiples, the gangsaw can maintain a production of 40,000 board-feet per 8-hour shift. (Photo: Wickes Brothers Division, The Wickes Corp.)

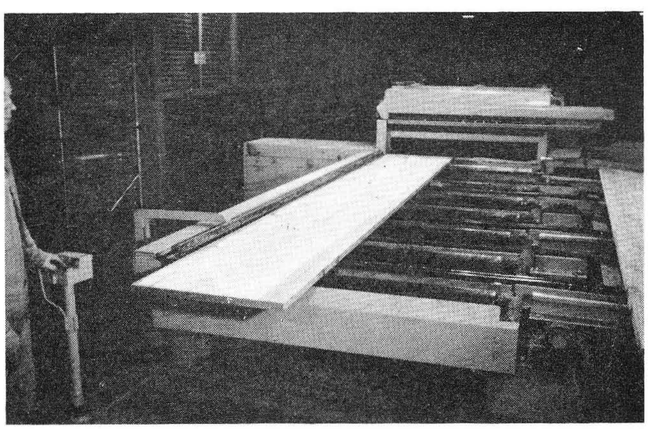


Fig. 18. Remotely-controlled, power-shift edger. Saw positions are indicated by special scales readily visible to operator. The edger delivers square-edged lumber to the grading chain. Edgings and sawdust are not wasted but are converted into fuel briquets for fireplace use. (Photo: The Ivory Pine Co.)

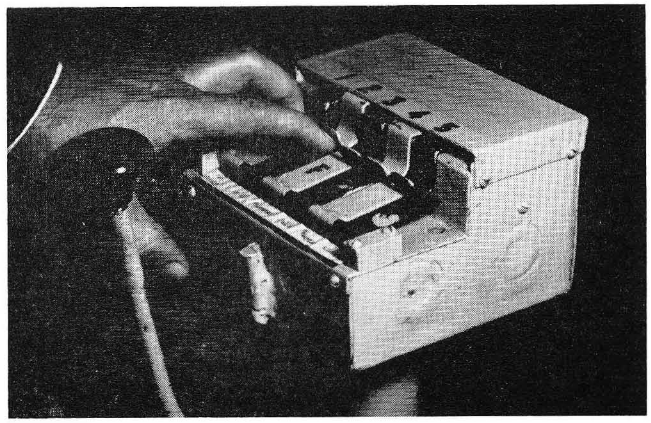


Fig. 19. Detail of control pedestal for power shift edger. All necessary functions are controlled from this station, including feed control, saw shift, and lubrication. (Photo: The Ivory Pine Co.)

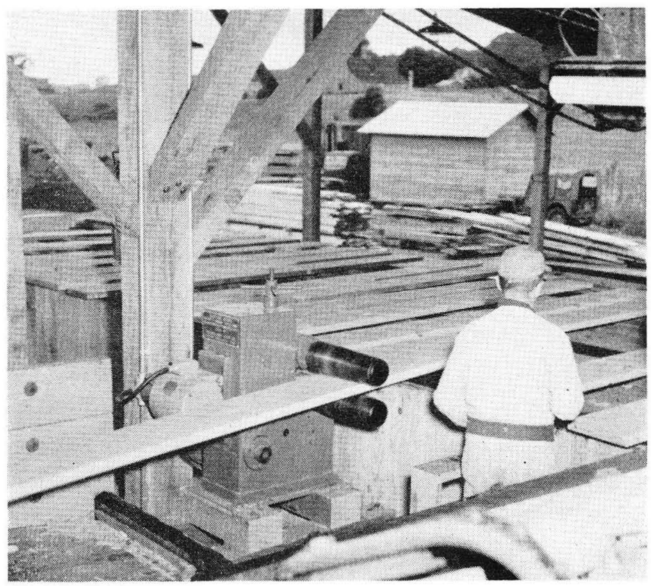


Fig. 20. The "Electric Swede" is equipped with smooth rolls and a 3-horsepower motor. In this operation, the grader pulls lumber to be resawn a few inches out from the lumber line where it is caught by the rolls of the "Electric Swede" and jerked onto a transfer chain leading to the resaw. (Photo: Moore Dry Kiln Co.)

If the board is to be surfaced, it is pulled 6 inches beyond the lumber line. A solenoid-operated switch opens a dropout admitting the board to single surfacer H (Fig. 21) which delivers the single-surfaced board to a transfer chain that feeds into single surfacer I. In the process of dropping onto the belt that feeds single surfacer I, the board turns over. Thus it is surfaced on

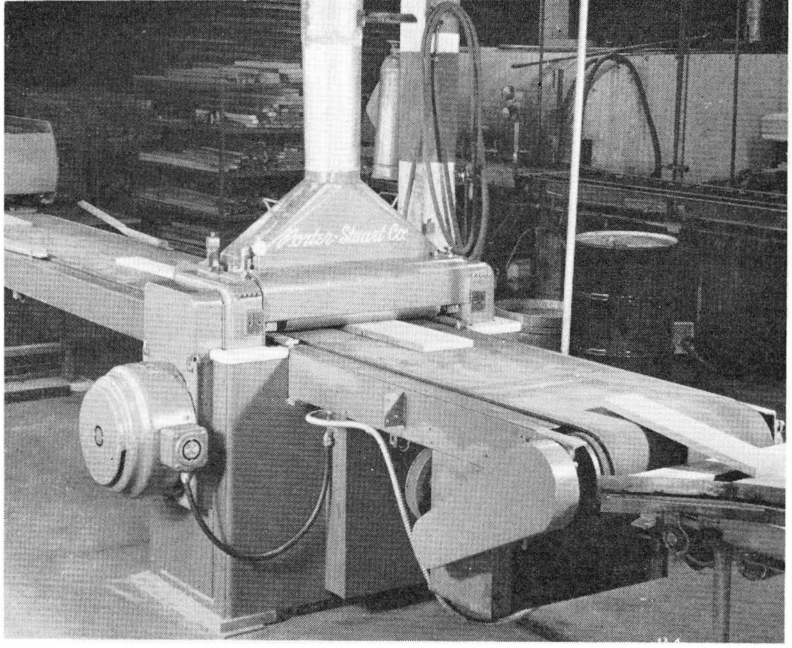


Fig. 21. Lumber for pallets can be planed by a pair of these single surfacers, each with continuous belt feed. The three-knife machine shown is not fast enough for the contemplated operation which calls for feed speeds in the vicinity of 500 lineal feet per minute; however, it illustrates the principle. A pair of these machines in series automatically produce accurately-thicknessed lumber planed on both sides (each board is mechanically turned over before entering the second surfacer). (Photo: Porter Stuart Co.)

both sides and thicknessed to 13/16 inch in the last operation before being delivered back to the grading chain.

Operator 8 takes each board as it leaves the mill and, via speedup belts, loads the lugged chain leading to the 16-deck sorter. Sorter operator number nine adjusts the switching mechanism to one of 16 positions which control the diversion of the board to one of 16 levels, depending on its size, grade or species (Figs. 22 and 23).

Since all the logs being sawn in any particular run are the same length, all the boards are also of the same length. Those boards which, because of rot or other excessive defects, are shorter than the standard board-length are diverted into the lowest position. From there they fall onto a belt. The belt conveys them to a chain which delivers them to man number 10 who operates a pair of trimsaws (Fig. 24). He salvages what he can from the board, sending the salvaged portion to circular sorting table K. Here, man number 11 sorts the board into the desired classification.

Most of the lumber, however, is diverted into the 16-tiered sorter, designated by letter L in Fig. 12 (Figs. 22 and 23 also show this equipment). As soon as any one of these tiers has accumulated a full load, stackerman number 12 empties that particular tier, allowing the lumber to be pulled toward him on powered chains. With his elevator-type stacking mechanism, he can build a stack of lumber, either with or without kiln or air-drying sticks (Fig. 25).

Fig. 22. Following the secondary manufacturing operations of surfacing and/or resawing, the lumber is sorted according to width, thickness, grade, etc. This view shows the sorter operator controlling the diversion of boards into a multideck sorter. The position of the slider bar operated by his right hand determines which level the board will seek. Each level of the sorter contains a particular grade or size of board. (Photo: The Ivory Pine Co.)

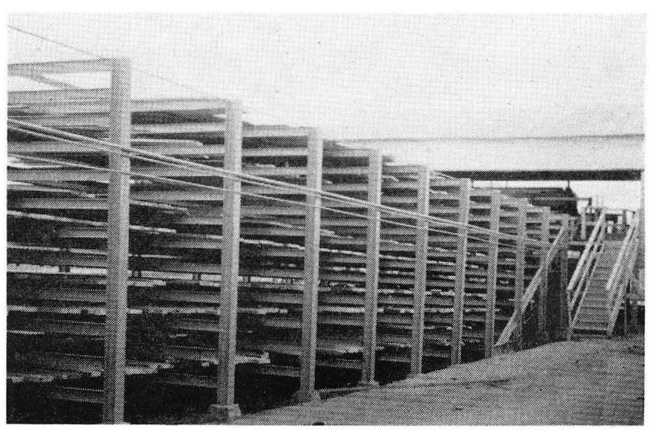


Fig. 23. View of a multideck lumber sorter looking from the sawmill in the direction of lumber movement and toward the lumber stacking station at the far end. Each level of lumber represents a separate sort. As each level fills with lumber, it is emptied onto powered chains that convey the entire sheet of stored boards to a mechanical stacker. (Photo: The Ivory Pine Co.)

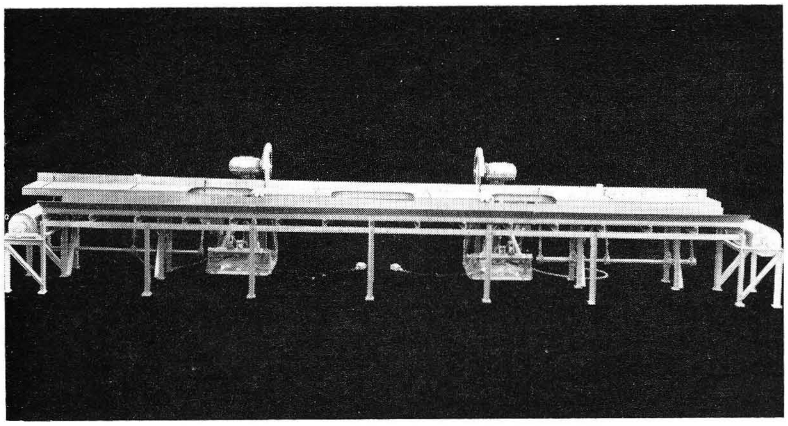


Fig. 24. Twin air-operated cutoff saws, with trim table, bell stops, air-operated kickoff levers and pulleys and trough for takeaway belt. The operator stands between the two saws and operates them with foot valves. This equipment is used to salvage shorts and lumber with excessive defect which is switched from the multideck sorter. For its location in the general plan, see Item J in Fig. 12. (Photo: Stetson-Ross Machine Co., Inc.)

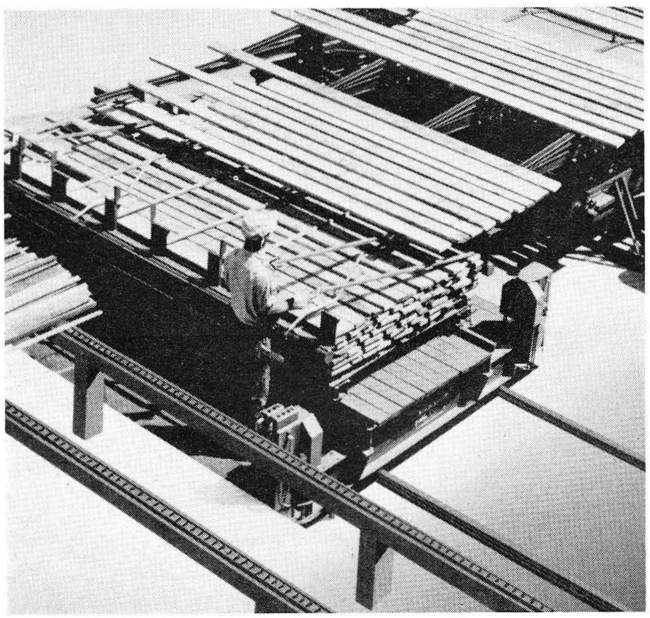


Fig. 25. Chain arm stacker that will stack with or without sticks as desired. In the proposed operation, the lumber packages will be short (i.e., 8 to 12 feet in length), and it will be easier for one man to place the sticks than it would be on the longer stock shown. This stacker, located at the end of the multideck sorter, can handle 40,000 board-feet per 8-hour shift. High-grade lumber stacked with sticks is delivered to the yard to be air dryed. Low-grade lumber is solidly piled in a package. It is cut to length in the package before delivery to the pallet plant. (Photo: Moore Dry Kiln Co.)

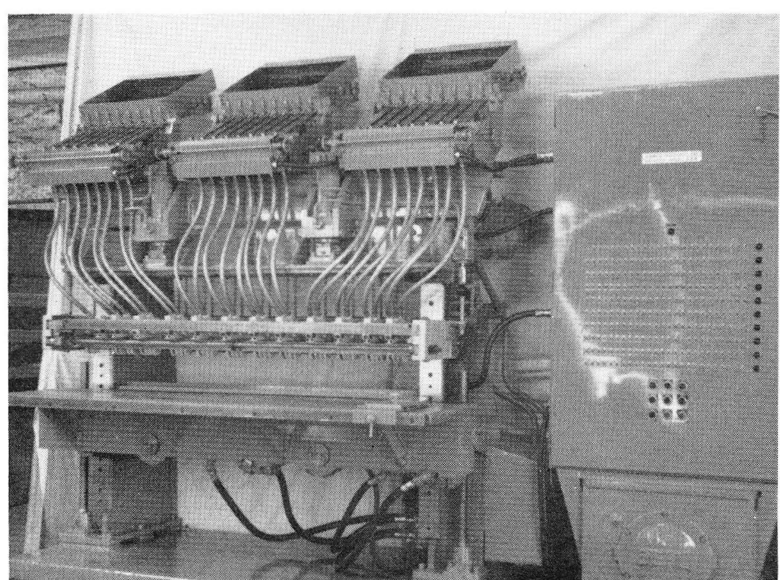
If the lumber grade is No. 1 common or better, he will build a stack 4 feet wide by 4 feet high, complete with air-drying sticks. After he has built the load, he will actuate end ram N which will even up the ends of the stack. Then the package will be lowered onto the rollcase. It is moved out to where it can be jacked away by powered chains and fork lifted to the yard for air-drying.

Lumber intended for the pallet plant will be solidly piled 4 feet wide and 1 foot high. End ram N will even up the stack. The bundle will then be lowered onto the rollcase and moved to cutoff saw P. Here, man number 13 will apply top and side clamps to hold the bundle in place. A saw will then cut the bundle to desired lengths for the pallet plant. The cut-to-length stock is then fork lifted to the nailing plant.

The nailing plant is housed in a 40- by 120-foot building. Two automatic nailing machines (Fig. 26) are manned by six men in addition to eight men who do hand nailing. One man moves stock to and away from the machines with a forklift. A second man steel-straps the plant output and spots loads; a third man does special boring and shaping for special orders.

At the end of the nailing operation, the pallets are forklift-loaded onto a fleet of six 225-horsepower tractor and semi-trailer combinations with 36 by 8 foot flatbeds (Figs. 7 and 8). These trailers

Fig. 26. Automatic nailer, 72-inch model. The hydraulically-powered heads can operate satisfactorily on the variable thicknesses of rough sawn stock. The console on the right controls the nailing pattern, combinations and cycles. Two of these versatile machines would be needed to nail pallets. Hand nailing supplements the machine nailers. (Photo: The G. M. Diehl Machine Works, Inc.)



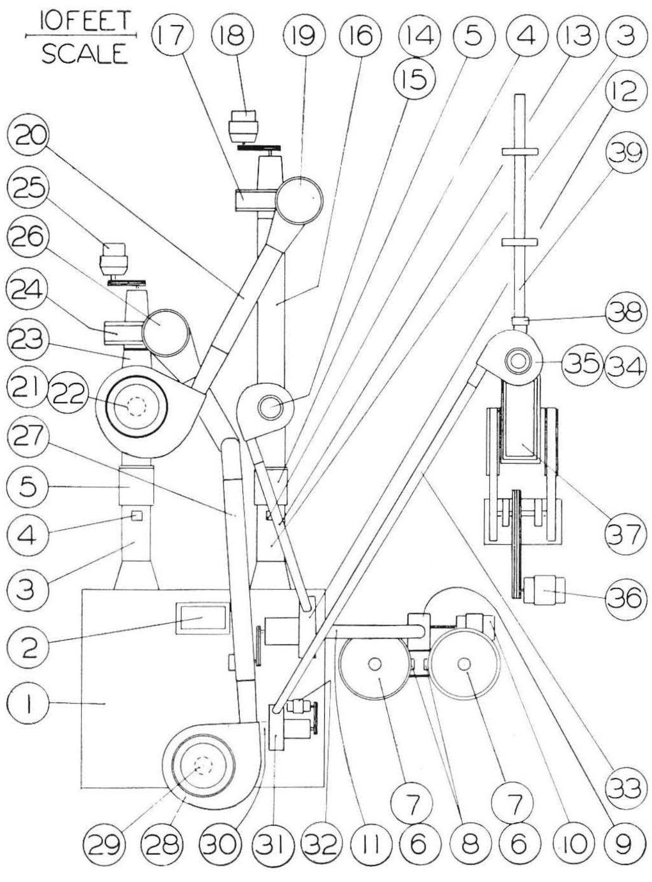


Fig. 27. Typical layout of briquetting plant.* The briquetting plant uses the hogged barky slabs, edgings and sawdust that would ordinarily be wasted by transforming this material into fuel briquets for fireplace use. The equipment shown is designed to operate 24 hours a day, 7 days a week, 50 weeks out of the year. The estimated capacity at 2 tons per hour is more than the required 14,530 tons per year.

Item number	Description
1	Twin furnace
2	Stack
3	Flue gas duct
4	Air inlet
5	Spark screens
6	Unground material bins
7	Vibrators
8	Unground material chutes
9	Grinding mill
10	Drive motors
11	Ground material duct
12	Ground material fan
13	Ground material duct
14	Cyclone-air separation
15	Ground material pipe
16	Ground material and flue gas duct
17	First fan-drying tower
18	Fan drive motor
19	First drying tower
20	Duct: part dry material
21	Cyclone: flue gas separation

deliver the finished pallets to industrial users within an average radius of 330 highway miles from the mill, each truck taking 2 days for a round trip.

It has been calculated that 60 percent of the cubic log content would end up in the briquet plant. This 60 percent of cubic volume is made up of sawdust, shavings, trimmed ends and defects, barky slabs, and barky edgings. By reducing the feller's specifications governing minimum top diameter of the tree-length logs, much additional material could be diverted from the log-bucking deck into the hog feeding the briquet plant.

Alternate briquet plants are diagrammed in Figs. 27 and 28. Basically, the process consists of hogging the green waste material to a relatively large particle size. This is followed by hammermilling (Fig. 29) which produces smaller and more uniform particle size.

The material is then passed through a one-or two-stage drier (Fig. 30). Heat is supplied by the products of combustion from some of the previously dried material. It is estimated that 20 percent of the total material available may be needed to dry the balance down to 8 percent moisture content. This would result in a net annual production of 14,530 tons of briquets on an 8 percent moisture content basis.

Following the drying operation, the material passes to storage bins which, in turn, feed the briquetting machines (Figs. 31 and 32). One type briquetting machine lays down the material in continuous, highly-compressed helixes delivered

(Fig. 27 continued)

22	Partly dried material pipe
23	Partly dried material and flue gas duct
24	Second fan-drying tower
25	Fan drive motor
26	Second drying tower
27	Duct: dry material
28	Cyclone: flue gas separation
29	Dry material to furnaces
30	Dry material and air inlet to fan
31	Dry material fan
32	Fan motor
33	Dry material duct
34	Cyclone: air separation
35	Dry material to press
36	Press drive motor
37	Glomera press
38	Hydraulic ram
39	Log tube

*Source: Sumner Iron Works, Everett, Washington.

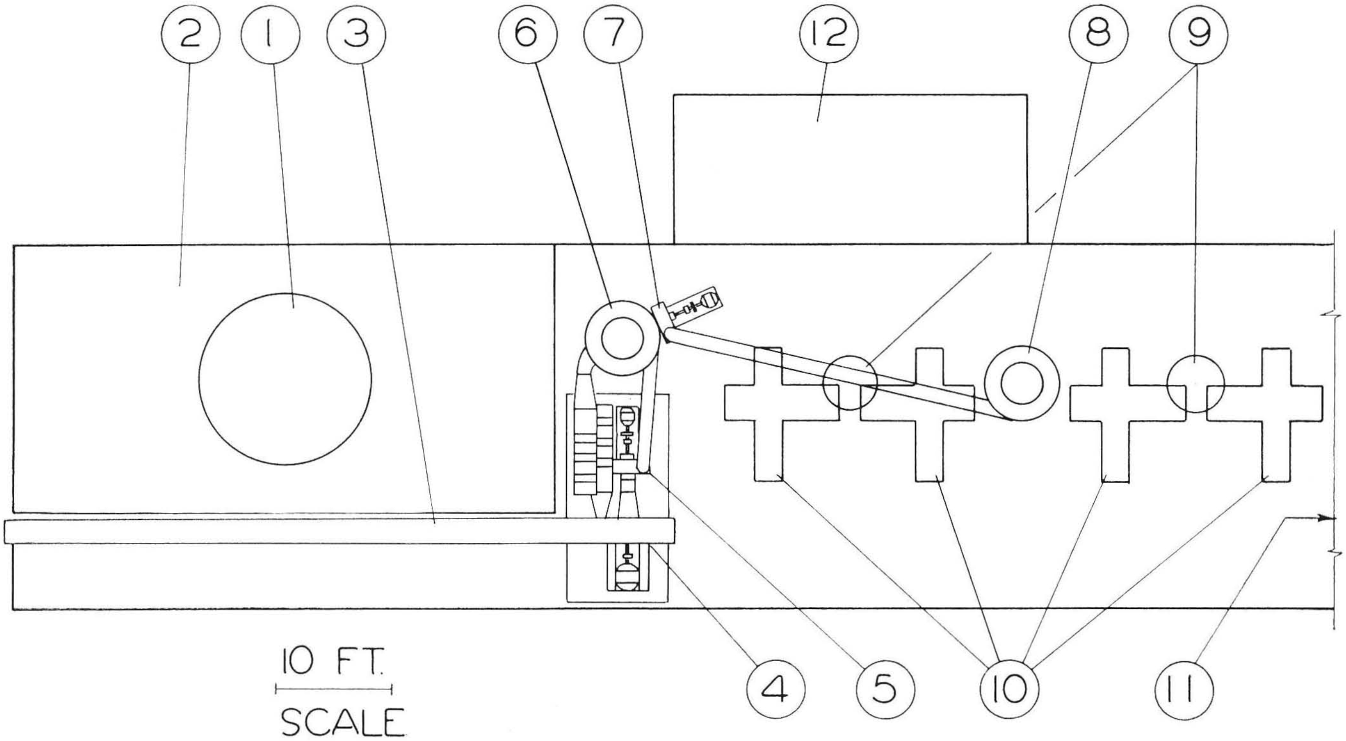


Fig. 28. Briquet plant layout (four machines).* Each of the four machines in this particular layout has a capacity of a half ton per hour. The plant is designed to operate around the clock for 50 weeks out of the year and, thus, has a capacity in excess of the required 14,530 tons per year. The end product is wood briquets for fireplace use. *Source: Wood Briquettes Inc., Lewiston, Idaho.

1. Refuse collector on fuel bin roof
2. Fuel bin
3. Conveyor to grinder
4. Grinder
5. First stage dryer
6. Second stage dryer
7. Fan
8. Collector on roof
9. Dry fuel tank
10. Briquet machines
11. Log storage

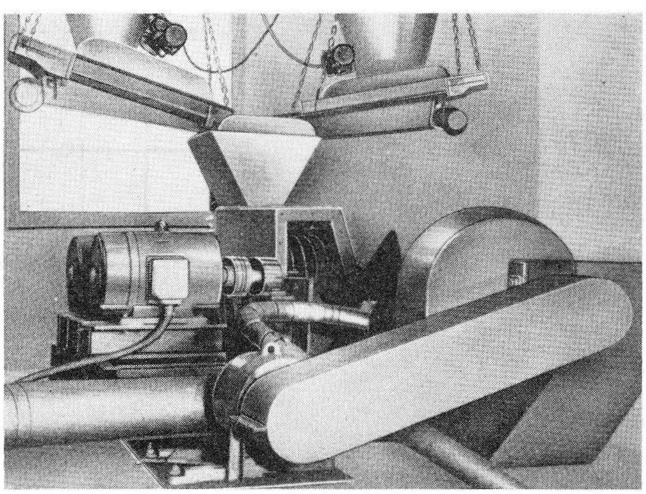


Fig. 29. As an initial step in the manufacture of briquets, this hammermill receives the hogged refuse from the sawmill and reduces it to a standard small size before drying in flash driers. The location of this equipment in the briquet plant is shown by Item 9 in Fig. 27. (Photo: Sumner Iron Works)

from a helically tipped feed screw against a hydraulically actuated pressure ram (Figs. 32 and 33).

The log produced is 4⅛ inches in diameter by 12¾ inches long and weighs about 8 pounds. Each machine has a capacity of about a half ton per hour; therefore, it takes four of these machines to handle the required output. Fig. 28 shows a typical layout.

A more recently developed machine uses a reciprocating ram to periodically force a new charge of material into a single discharge nozzle or tube (Figs. 31 and 34). While this type of machine is available in varying capacities, the machine proposed for the plant under discussion has a capacity of more than 2 tons per hour (Fig. 27).

The plant investment would be about the same for both of these machine types if the entire briquetting plant is considered as a whole. Two operators per shift are required to run the plant. One man would be needed during the day shift to fork-lift-load the three 26-ton trucks required to haul the product to the wholesaler's distribution points (an average hauling radius of perhaps 220 miles).

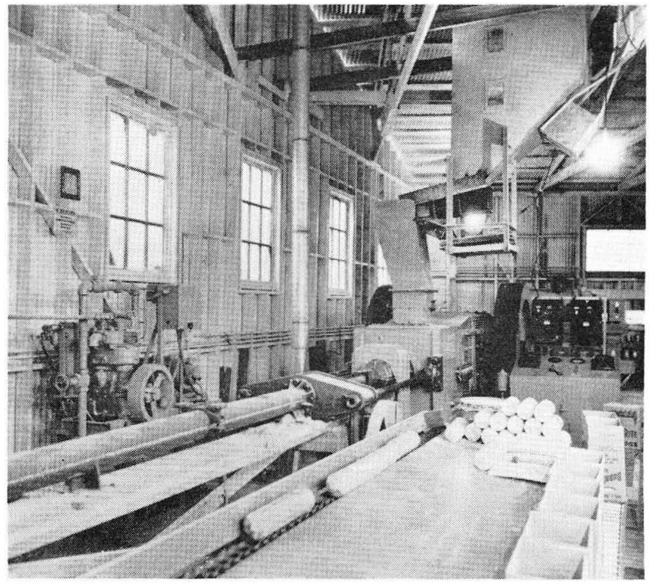


Fig. 31. Extrusion through this press is the final major step in the manufacture of fireplace-size log briquets from wood waste. Dry refuse (of controlled particle size) is admitted from the overhead storage hopper. The log tube extends to the left. Capacity of this machine ranges up to 2 tons per hour. See Item 37 in Fig. 27 for the location of this equipment in the manufacturing process. (Photo: Sumner Iron Works)

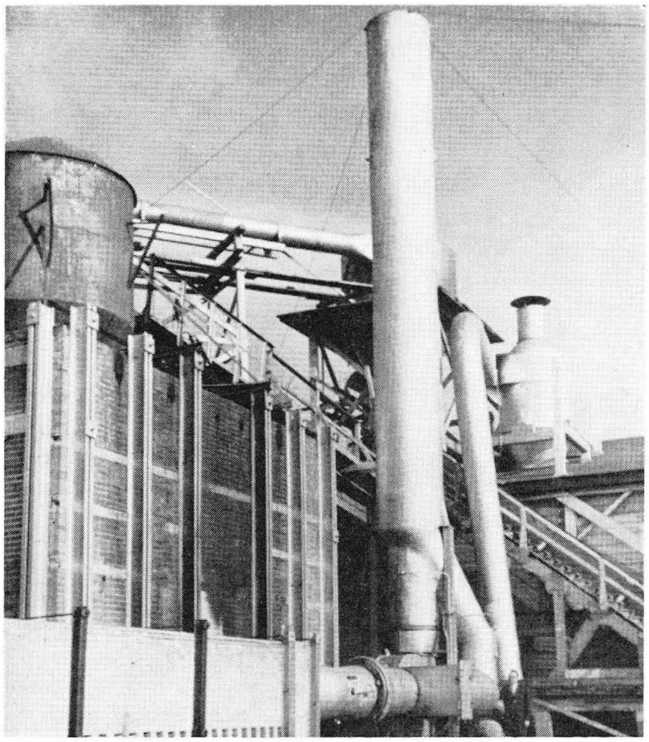


Fig. 30. The second step in converting wet wood waste into fuel briquets involves drying the previously hammermilled refuse in flash driers. The first stage of a two-stage dryer is shown here. See Item 19 in Fig. 27 for the location of this tower. (Photo: Sumner Iron Works)

Estimate of Capital Requirement

A detailed estimate of the plant investment is outlined in Table 8. The estimated total requirement in plant investment is $1,084,206. Of this total, logging and log hauling equipment accounts for 13.7 percent; log bucking and sorting equipment, 4.8 percent; sawmilling and lumber sorting equipment, 33.7 percent; nailing equipment, 9.8 percent; briquetting equipment, 20.6 percent; and equipment to transport the pallets and briquets to market, 17.4 percent.

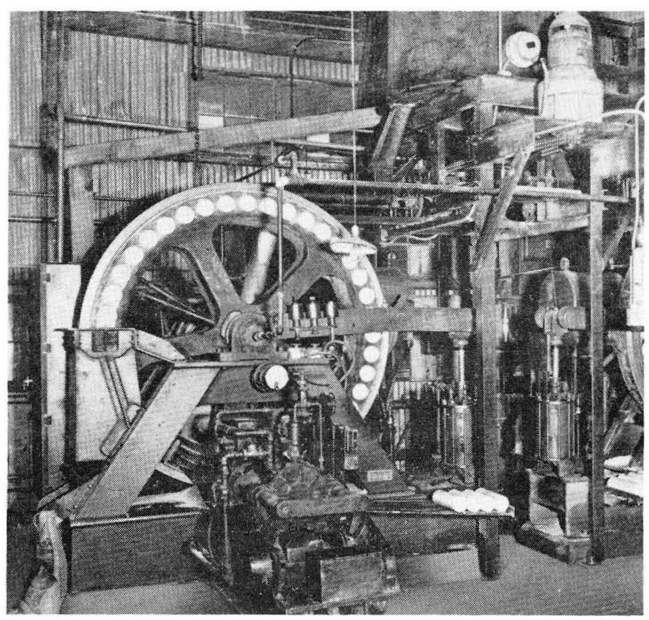


Fig. 32. This machine illustrates a system of forming logs singly through a combination of pressing screw, die and pressure regulating cylinder. The capacity of each machine is about one-half ton per hour. See Item 10 in Fig. 28 for the location of the machine in the briquet plant layout. (Photo: Wood Briquettes, Inc.)

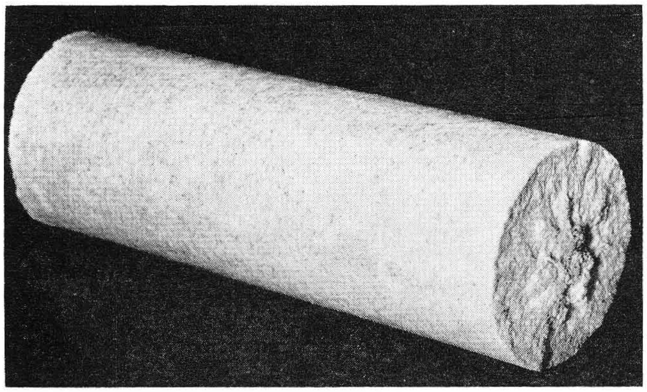


Fig. 33. This photograph shows the type of briquet made by the process illustrated in Figures 28 and 32. The log measures 4⅛-inches in diameter and weighs about 8 pounds. It burns with practically no smoke and leaves almost no ash. (Photo: Wood Briquettes, Inc.)

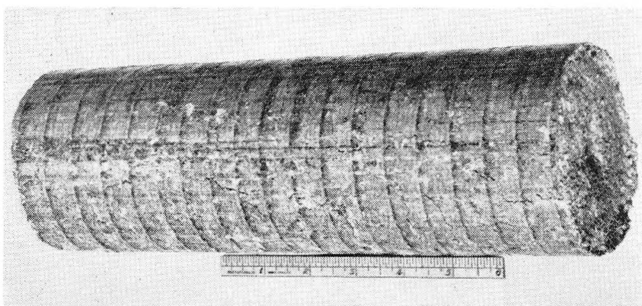


Fig. 34. This photograph illustrates the briquet made by the process shown in Figs. 27 and 31. The log produced measures 3¾ inches in diameter by 12 inches long and it weighs a little over 5 pounds. The ring structure of this log shows clearly in the photograph and is due to the manner in which the log is extruded through the single log tube. (Photo: Sumner Iron Works)

TABLE 8—Resume of capital expenditure involved

Function	Equipment price		Sub-totals
Felling	Five chain saws and tools at $350 per set		$ 1,750
Skidding	Three track-laying tractors, 48 drawbar hp. each equipped with towing winch, pans and duplicate sets of chokers at $11,000 per machine		33,000
Roadbuilding	One tractor, 75 drawbar hp. with hyd. angling blade and winch at.	$17,650	
	One 50-hp. motor grader including snowplow for winter operation at	10,000	27,650
Loading	One 5-ton rubber mounted, mobile crane equipped with grapple at.	$25,000	
Trucking to mill	Three 220-hp. tractors equipped with 9,000-pound capacity front axles and 2,2000-pound rear axles, together with 20-ton trailers having 109-inch tandem axles, at $17,000 per machine	51,000	
Offloading	One 20-ton stationary offloading crane at	10,000	86,000

TABLE 8—Continued

Function	Equipment price			Sub-totals
Log bucking	Live deck leading to bucking saw.		$4,000	
Log sorting	Rollcase, clamp jaws, log cutoff saw and log kickers		8,000	
	Live deck leading to sorter		1,500	
	Log sorting device for 20 sorts		12,500	
	Hog and blower for trim ends and defects		5,000	
	Heavy duty rubber-tired fork lift for decking and transporting logs in the yard (one-half charged to this operation)		7,000	
	Office and equipment at $20,000, 40 acres land at $8,000, electric service and lighting at $5,000, grading and surfacing at $5,000, siding at $5,000 (one-fourth charged to this operation)		10,750	
	Engineering at 6% of $48,750		2,925	$51,675
Log breakdown. Gangsawing Resawing Surfacing Sorting Stacking (with or without sticks) Trimming to length Yard transport. Refuse hogging.	Major machinery items:			
	Skrag mill	$10,000		
	Crane to load gangsaw	7,500		
	Gangsaw with equipment	28,500		
	Power shift edger	11,000		
	Two 500f.p.m., 12K belt feed single surfacers at $10,000	20,000		
	Electric "Swede"	1,000		
	Resaw (centering)	14,000		
	Twin trim saws	4,000		
	Turntable sorter	1,000		
	Multideck sorter with infeed and outfeed, stacker, load evener, rollcase and jack chains	75,000		
	Package cutoff saw with side and top bundle clamps	5,000		
	Air compressor	4,000		
	Hog	5,000		
	Grinding room equipment	6,000		
	Fork lift for lumber	7,000		
	Fork lift for logs (one-half charged against this operation)	7,000		
			$206,000	
	Conveyors		68,000	
	Sawmill building, footings for machines, wiring and lighting		60,000	
	Office and equipment at $20,000, 40 acres land at $8,000, electric service and yard lighting at $5,000, grading and surfacing at $5,000 siding at $5,000 (one-fourth charged to this operation)		10,750	
	Engineering fee at 6% of $344,750		20,685	$365,435
Nailing	Two automatic nailers at $21,000 per machine		$42,000	
	Eight portable air-operated hand		9,670	
	nailers at $1,220 each		9,670	
	Two portable pneumatic nailers at $135 each		270	
	Boring machine		1,000	
	Steel strapping equipment		500	
	Fork lift for pallet stock		7,000	
	Nailing plant building		24,000	
	Jigs, fixtures and conveyors		5,000	
	Office and equipment at $20,000, 40 acres of land at $8,000, electric service and yard lighting at $5,000 grading and surfacing at $5,000, siding at $5,000 (one-fourth charged to this operation)		10,750	
	Engineering fee at 6% of $100,190		6,011	$106,201
Transporting pallets to market	Six 220-hp. tractors equipped with 9,000-pound capacity front axles and 22,000-pound rear axles, together with 20-ton trailers having 109-inch tandem axles, at $17,300 per unit		$103,800	
	Two additional trailers for preloading, at $4,900 each		9,800	
	Fueling lubrication and maintenance facilities $5,000 (charge one-half against this operation)		2,500	$116,100

(Continued on page 24)

TABLE 8—Concluded

Function	Equipment price		Sub-totals
Briquetting.....	Entire machinery and plant, including storage and loading dock and fork lift............	$200,000	
	Office and equipment at $20,000, 40 acres of land at $8,000 electric service and yard lighting at $5,000, siding at $5,000 (one-fourth charged to this operation)	10,750	
	Engineering fee at 6% of $210,750	12,645	
			$223,395
Transporting briquets to market	Three 220-hp. tractors equipped with 9,000-pound capacity front axles and 38,000-pound rear axles, together with 109-inch tandem, open top 26-ton trailers with rollback tarp at $23,500..	$70,500	
	Fueling and maintenance facilities at..........................	2,500	
			$73,000
	Total investment in facilities..........		$1,084,206

Analysis of Cost of Goods Sold

A detailed estimate of cost of goods sold is outlined in Tables 9, 10 and 11. Exclusive of general and selling expenses, the total manufacturing cost of goods sold is $940,208. Direct labor represents 27.2 percent of this total; purchases account for 13.4 percent; and manufacturing overhead is 59.4 percent of the total. Depreciation (which is part of manufacturing overhead) accounts for 23 percent of the total manufacturing cost of goods sold.

Table 11 shows the profit margins (including consideration of general and selling expenses) on pallets, No. 1 common and better lumber, and briquets to be $11.70/M, $64.82/M and $4.94/ton, respectively.

*TABLE 9—Resume of cost of goods sold**

Function	Expense (annual)			Sub-totals
Felling Topping Limbing	Purchases: 9,620M of mixed hardwoods at $6.50/M (board scale)......................		$62,530	
	Direct labor: 10 men (five two-man teams) at $2/hr., 8-hr. days, 243-day yr..................		38,880	
	Manufacturing overhead:			
	Oil and gas for saws at $0.20/M..........	$1,925		
	Saw maintenance $0.10/M..........	962		
	Transporting men to job site...............	1,700		
	Vacations and holidays.	2,720		
	Depreciation..........	350		

*Refer to Table 10 for basic assumptions regarding overhead expense items.

TABLE 9—Continued

Function	Expense (annual)			Sub-totals
	Social security tax.....	840		
	State and federal Unemployment tax.....	1,000		
	Workmen's compensation...............	3,328		
	Miscellaneous at 5% of direct labor.........	1,944		
			14,769	
				$116,179
Roadbuilding...	Purchases:...................		0	
	Direct labor: three men (one grader operator, one tractor operator and one helper) at $1.50/hr., 8-hr. day, 243-day yr.........		$8,748	
	Manufacturing overhead:			
	Operating cost of motor grader (1,944 hr./yr.) at $1.12/hr.........	$2,180		
	Operating cost of tractor (1,944 hr./yr.) at $1.79/hr...........	3,480		
	Vacations and holidays.	612		
	Depreciation..........	5,530		
	Social security tax.....	252		
	State and federal unemployment tax.....	300		
	Workmen's compensation...............	749		
	Miscellaneous at 5% of direct labor.........	437		
			13,540	
				$22,288
Skidding......	Purchases:...................		0	
	Direct labor: three tractor operators at $1.50/hr., three choker setters at $1.25/hr., one unhooker at $1.25/hr...........		$18,468	
	Manufacturing overhead:			
	Operating cost per tractor/hr. $1.144 1,944 hrs./yr. (3).........	$6,676		
	Foreman.............	6,000		
	Vacations and holidays.	1,292		
	Depreciation..........	6,600		
	Social security tax.....	588		
	State and federal unemployment tax.....	700		
	Workmen's compensation...............	1,957		
	Miscellaneous at 5% of direct labor.........	923		
			24,736	$43,204
Loading....... Trucking to mill	Purchases:...................		0	
	Direct labor: $1.50/hr. 243 days			
	One grapple operator			
	One helper			
	Three truck drivers			
Offloading.....	One offloader			
Scaling........	One scaler			
			$20,412	
	Manufacturing overhead:			
	Grapple operating cost at $0.80/hr.........	$1,555		
	Crane operating cost...	1,200		
	Truck operating costs each at $0.178/mile for fuel, oil, grease, repairs and tires, three trucks, each travelling 12,150 miles/yr......	6,480		
	Truck, license, and insurance, $870 each ..	2,610		
	Vacations and holidays.	1,428		
	Depreciation..........	17,200		
	Social security tax.....	588		
	State and federal unemployment tax.....	700		
	Workmen's compensation...............	1,633		
	Miscellaneous at 5% direct labor..........	1,020		
			$34,414	
				$54,826

(Continued on page 25)

TABLE 9—Continued

Function	Expense (annual)			Sub-totals
Bucking Log sorting	Purchases:		0	
	Direct labor: (three and a half men). One log deck man, one saw operator, one sorter controller, one man on fork lift to transport logs to sorted deck storage (one-half charged to this operation) $1.50/hr.		$10,206	
	Manufacturing overhead:			
	Machinery repairs at 20% of direct labor	$2,041		
	Vacations and holidays	714		
	Depreciation	10,335		
	Social security tax	294		
	State and federal unemployment tax	350		
	Workmen's compensation	816		
	Miscellaneous at 5% of direct labor	510		
	County and township tax	775		
			$15,835	
				$26,041
Log breakdown Gangsawing Resawing Surfacing Sorting Stacking (with or without sticks) Trimming to length Yard transport Refuse hogging	Purchases:		0	
	Direct labor: (14½ men), 13 men (refer to mill layout), one fork lift operator (lumber), one fork lift operator (logs) (one-half charged to this operation). All at $1.50/hr., 243 days/yr.		$42,282	
	Manufacturing overhead:			
	Foreman (salary)	$6,000		
	Maintenance man	2,916		
	Electrician	2,916		
	Filer	3,888		
	Vacations and holidays	3,638		
	Maintenance and repairs to plant machinery at 20% of direct labor	8,456		
	Depreciation	73,087		
	Plant cleaning expense at 3% of direct labor	1,268		
	Power consumption of (50,000) (12) kw.-hr./yr. at $0.01108/kw.-hr.	6,640		
	Fuel and water	1,200		
	Social security tax	1,554		
	State and Federal unemployment tax	1,850		
	Workman's compensation	4,931		
	County and Township tax	5,482		
	Miscellaneous at 5% of direct labor	2,114		
			$125,940	
				$168,222
Nailing (8,466M/yr.)	Purchases:			
	Nails and staples at $7.50/M board-feet nailed		$63,495	
	Direct labor: (17 men), six men on automatic nailers, eight men hand nailing, one man on special boring work, etc., one fork lift man, one man using steel strapper. All at $1.50/hr. 243 days/yr.		$49,572	
	Manufacturing overhead:			
	Foreman at $2.00/hr.	$3,888		
	Vacation and holidays	3,740		
	Maintenance and repairs to plant machinery at 10% of direct labor	4,957		
	Plant cleaning expense at 3% of direct labor	1,487		
	Depreciation	21,240		
	Social security tax	1,512		
	State and Federal un-			

(Continued in column 2)

TABLE 9—Continued

Function	Expense (annual)			Sub-totals
	employment tax	$1,800		
	Workmen's compensation	4,576		
	County and township tax	1,593		
	Miscellaneous at 5% of Direct Labor	2,479		
			$47,272	
				$160,339
Transporting pallets to market (330 miles average radius)	Purchases:		0	
	Direct labor: six drivers at 330 miles/day—8 hr. day, 243 days/yr. at $2.40/hr.		$27,994	
	Manufacturing overhead:			
	one maintenance man	$2,916		
	Vacations and holidays	2,162		
	Truck operating costs, each at $0.127/mile for fuel, oil, grease, repairs and tires. 80,190 miles/yr. each six trucks	62,400		
	Truck license and insurance at $1,570/truck	10,420		
	Depreciation	23,220		
	Social security tax	588		
	State and Federal unemployment tax	700		
	Workmen's compensation	2,646		
	Miscellaneous at 5% of direct labor	1,400		
			$106,452	
				$134,446
Briquetting (14,530 tons/year)	Purchases:		0	
	Direct labor: (six men), 2 men per shift, three shifts, 351 days/yr. at $1.50/hr.		$25,272	
	Manufacturing overhead:			
	Foreman at $2/hr. one shift, 351 days	$5,616		
	Fork lift operator one shift, 243 days at $1.50/hr.	2,916		
	Vacations and holidays	1,700		
	Maintenance at $1/ton	14,530		
	Royalty at $0.50/ton (applies to "Presto-log" process only)	7,265		
	Power consumption of (250,000) (12) kw.-hr./yr. at $0.01108/kw.-hr.	33,200		
	Depreciation	44,679		
	Social security tax	672		
	State and Federal unemployment tax	800		
	Workmen's compensation	2,840		
	County and township tax	3,351		
	Miscellaneous at 5% of direct labor	1,286		
			$118,855	
				$144,127
Transporting briquets to market (220 miles average radius)	Purchases:		0	
	Direct labor: (three men), three truck drivers each driving 330 miles/day 8-hr. days, 243 days/yr. at $2.40/hr.		$13,997	
	Manufacturing overhead:			
	Vacations and holidays	$979		
	Truck operating costs each at $0.140/mile for fuel, oil, grease, repairs and tires. 80,190 miles/yr. each, three trucks	33,800		
	Truck licenses and insurance at $1,570/truck	4,710		

(Continued on page 26)

TABLE 9—Concluded

Function	Expense (annual)	Sub-totals
	Depreciation..........$14,600 Social security tax..... 252 State and Federal unemployment tax..... 300 Workmen's compensation................ 1,198 Miscellaneous at 5% direct labor......... 700 $56,539	$70,536
	Grand total.......................	$940,208

TABLE 10—Assumptions regarding overhead expense items

Insurance on plant: 0.335% of value/year.

Depreciation of all equipment on 5-year straight line basis. (This is, of course, a simplification of the situation; in practice, each class of machinery has a different depreciation period. Further, the management would have the option of using either the double declining balance system or the sum of digits system, both of which give an accelerated rate of depreciation during the first years.)

Social security taxes: 2% of first $4,200 of each employee; therefore, use the figure of $84/year/employee.

State and federal unemployment tax:

State	3%	
Federal	0.3%	
		of first $3,000 of each employee.
Total	3.3%	Therefore, use $100/employee/year.

Workman's compensation: This rate varies from 4-6% for good sawmills to 10-12% for poor sawmills of total labor payroll.
Striking an average, use 8% of total payroll.

Tax on business receipts is approximated at $6½/(1,000 dollars of business divided by 2).

i.e., $\$6\frac{1}{2}\left\{\frac{\text{annual gross receipts}}{2{,}000}\right\}$

County and township taxes in the area under consideration will be about 15 mills/$1,000 property valuation (this valuation excludes trucks and other mobile equipment).

Estimate of Net Annual Profit from Operations Before Federal Income Taxes

Net annual sales are estimated at $1,298,928 (Table 12 and Fig. 36). Fig. 35 shows the disposition of the net sales dollar. Fig. 37 shows the division of profit from operations according to product.

Table 13 shows an estimated annual net profit before federal income taxes of $246,270, or 19.0 percent of net sales.

Pallets account for 65.2 percent of net sales and 40.3 percent of the profit. No. 1 common and better lumber accounts for 10.7 percent of net sales and 30.5 percent of the profit. Briquets account for 24.1 percent of net sales and 29.2 percent of the profit.

TABLE 11—Cost—Margin tabulation per sales unit

Cost category	Unit cost of goods sold (exclusive of general and selling overhead)		
	Pallets $/M	#1 Common and better lumber $/M	Briquets $/ton
Stumpage................	$6.50	$6.50	
Felling Topping Limbing................	5.58	5.58	
Skidding.................	4.49	4.49	
Roadbuilding.............	2.32	2.32	
Loading Trucking to mill Offloading Scaling.................	5.70	5.70	
Log bucking Log sorting.............	2.71	2.71	
Log breakdown Gangsawing Resawing Surfacing Sorting Stacking Trimming Hogging................	17.50	17.50	
Nailing...................	18.95		
Transporting pallets to market........	15.90		
Manufacture of briquets....			$9.93
Transporting briquets to market...............			4.86
Total unit cost of goods sold (exclusive of general and selling overhead)........	$79.65	$44.80	$14.79
Proportional share of general and selling overhead according to share of net sales...................	8.65	10.38	1.87
Total cost/unit........	$88.30	$55.18	$16.66
Sales price/unit.......	$100.00	$120.00	$21.60
Margin/unit.............	$11.70	$64.82	$4.94

TABLE 12—Annual net sales

Pallets (8,466M)($100/M)......................	$846,600
No. 1 Common and better lumber (1,154M)($120/M)......................	138,480
Briquets (log size for fireplace use) (14,530 tons)($21.60/ton)................	313,848
	$1,298,928

These tables and charts show that, if half the profit is claimed by the federal government in the form of income taxes and the investors are given an annual 5 percent return on their investment, about 6 percent of the investment (or $68,925) remains to be ploughed back into the business for expansion or simply to keep abreast of the competition.

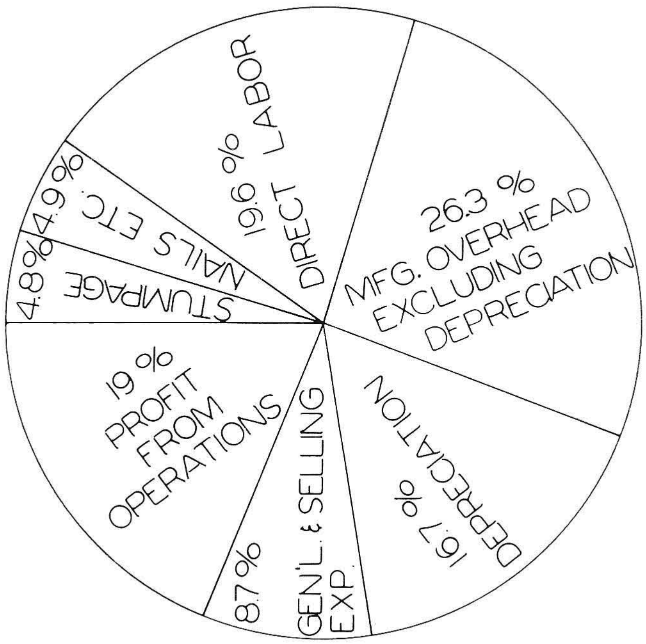


Fig. 35. Disposition of net sales dollar.

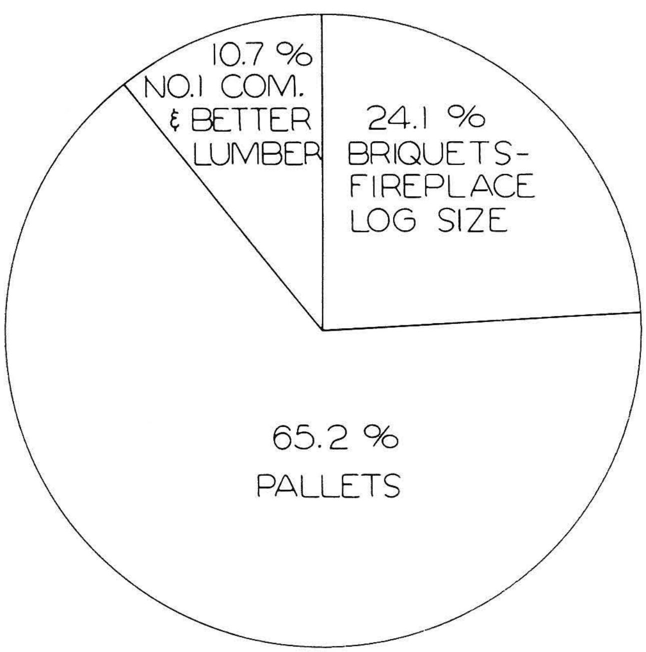


Fig. 36. Division of net sales according to product.

Estimate of Total Staff and Payroll

Table 14 estimates staff and payroll. The proposed number of employees in the entire operation totals 95. Of this total, 81 percent are direct

TABLE 13—Statement of income (annual)

NET SALES (Table 12)			$1,298,928
COST OF GOODS SOLD (Table 9)			940,208
GROSS PROFIT FROM SALES			$ 358,720
Ratio to net sales			27.6%
SELLING AND GENERAL EXPENSES			
Salaries			
General manager	$15,000		
Three salesmen at $7,200 each	21,600		
One engineer	6,000		
One forester	6,000		
One accountant	6,000		
Two clerical at $3,000 each	6,000		
		$60,600	
Traveling expense		20,000	
Telephone and telegraph		5,000	
Advertising		10,000	
Legal and auditing		5,000	
Tax on business receipts		4,350	
Insurance premiums on plant (fire and other)		2,500	
Miscellaneous		5,000	
Total selling and general expense			$112,450
Ratio to net sales			8.67%
PROFIT FROM OPERATIONS (before income taxes)			$246,270
Ratio to net sales			19.0%
Ratio to total investment in facilities			22.7%

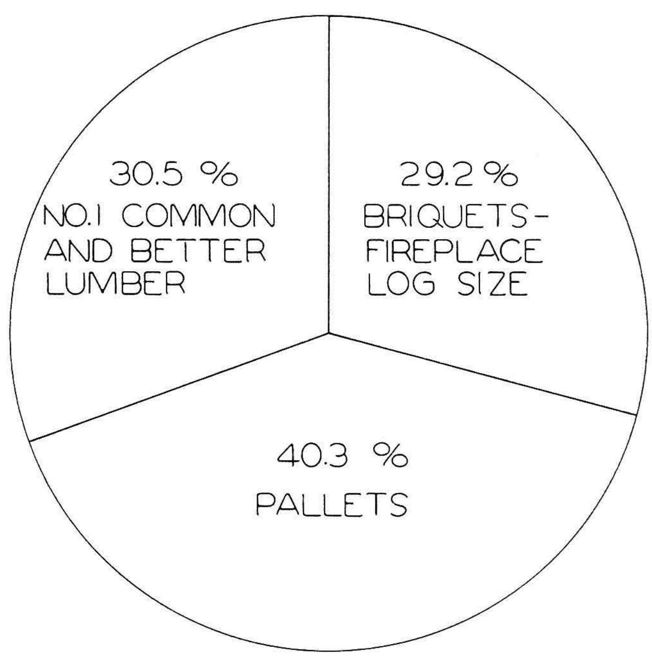


Fig. 37. Division of profit from operations according to product.

labor, 9.5 percent are manufacturing overhead, and 9.5 percent are general and selling overhead.

The average manufacturing hourly wage is estimated at $1.74 per hour, and the total annual payroll at $372,490.

TABLE 14—Manpower to staff operations

Phase of operations	Direct labor	Manufacturing overhead	General and selling overhead
Felling, topping, limbing....	10		
Roadbuilding............	3		
Skidding................	7	1	
Loading, trucking to mill, offloading, scaling.......	7		
Bucking and log sorting....	3½		
Log breakdown Gangsawing Resawing Surfacing Sorting Stacking Trimming.............	14½	4	
Nailing..................	17	1	
Transporting pallets to market................	6	1	
Briquetting...............	6	2	
Transporting briquets to market................	3		
General and selling overhead..............			9
	77	9	9

Total employed in direct labor and manufacturing overhead................................	86
Total manufacturing payroll (excluding general and selling overhead)......................	$311,890
Average manufacturing hourly wage (including 17 days of paid vacations and holidays)........	$1.74/hr.
Total number of employees....................	95
Total annual payroll..........................	$372,490

Silvicultural Considerations

Depending on the manner in which the logging is performed, the operation may or may not be desirable from a silvicultural viewpoint. This aspect would be largely controlled by the management's long range forest policy as outlined by the company forester.

The subject is complex and the possibilities are many. It is probable that a short discussion cannot do justice to the problem. However, at the risk of oversimplification, three possibilities are suggested: (a) a sanitation or thinning cut in a managed, mixed hardwood stand; (b) a relatively clear-cut of undesirable species (such as oak on a poor site) before eradication and replanting with a more desirable species; or (c) clear cut of a mature stand (such as aspen) before regeneration.

Since none of these possibilities is detrimental to the forest resource from a silvicultural viewpoint and since the manufacturing plant has no contaminating effluent (and no sizable water demand), it is unlikely that the operation would have a harmful effect on fish and wildlife. Some may argue that the gradual replacement of scrub oak forests with more productive pine forests would force adjustment of the deer population, but perhaps this result would be justified if the forest resource is sufficiently improved.

Operation of a pulpwood concentration yard would probably be a desirable addition to the activity of this plant. By this means, utilization of the pulp species could be improved considerably.

CONCLUSIONS

The plan developed herein requires a plant investment of about 1 million dollars to achieve gross annual sales of about 1.3 million dollars, yielding a calculated net profit before federal income taxes of about $246,000, or 22.7 percent of investment. The proposed plant would employ about 95 people with an estimated annual payroll of $372,000.

The operation would produce nearly 10 million board-feet of lumber per year. About 12 percent of this total would be sold as air-dried No. 1 common and better lumber, the balance being manufactured into wooden pallets. In addition, about 14,530 tons of fireplace-size log briquets would be produced each year.

If the assumptions are valid, the operation would be moderately profitable. The profit picture could be considerably more attractive if the pallet selling price of $100/1,000 board-feet proves to be unnecessarily competitive. It is suspected that this is the case.

In addition to the monetary returns from a profitable enterprise, the manufacturer would have the satisfaction of constructively contributing to the stable economic growth of the area. At the same time, he would be assisting in the rehabilitation of a depleted forest resource.

3.5 M